

PALÆONTOGRAPHICAL SOCIETY.

BRITISH
CARBONIFEROUS BRACHIOPODA.

PART V.—FOURTH PORTION.

BRITISH FOSSIL REPTILIA

FROM

THE OOLITIC FORMATIONS.

PART FIRST.

SCELIDOSAURUS HARRISONII AND
PLIOSAURUS GRANDIS.

THE EOCENE MOLLUSCA.

PART I.

BIVALVES.

1861.

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A MONOGRAPH
OF
BRITISH
CARBONIFEROUS BRACHIOPODA.

BY
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ETC.

PART V.
FOURTH PORTION.

LONDON:
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1861.

denotes that a pedicle muscle must have existed, although the foramen became closed as soon as the animal found it could dispense with the moorings required during the early stages of its development.¹

In the interior of the dorsal valve the cardinal process is divided into two lobes, and not connate with the diverging socket-ridges. From the base of this a slight median ridge runs down and separates the two pairs of adductor or occlusor scars, which are bordered by prominent ridges. The vascular impressions consist of large primary vessels which run at once direct from near the centre of the valve, to a short distance of the frontal margin, when they become reflected on either side to surround the ovarian spaces, and, near the margin, some of the vessels bifurcate several times.

Dimensions very variable: a large example measured, length 17, breadth 33 lines.

Obs. As may be observed from the synonyms and references given (and which could have been considerably increased in number), this species has already been located in at least six genera, and has received twelve or more specific denominations. It is not, however, surprising that before the class had been sufficiently investigated, and while efforts were being made to value and define the different interior characters, as a means of classification, that geologists and palæontologists should have felt uncertain where to locate this and other species, so that the different generic denominations may thus be easily and naturally accounted for. We next come to the specific denominations; and here we open out a field susceptible of much divergence in opinion, for the preconceived opinions of some palæontologists and geologists make them averse to recognise the existence of the same species in so extensive a vertical range as the *Silurian*, *Devonian*, and *Carboniferous* periods; and although the greater number of palæontologists have admitted, in their various works, that it was scarcely possible to separate the specimens of the shell as found in the three great divisions of the Palæozoic period, they still preferred to retain for each a distinct specific denomination: and this will explain the principal cause of the many names the shell we are now describing has received at different periods and from different hands.

In 1836, while describing the Carboniferous shell, Professor Phillips observes:—"I cannot distinguish this from the Dudley species, *L. depressa*;" and the same author begins the description of his *Prod. analoga* by stating that, "Perhaps this is really different from the last (*L. depressa*), but it is difficult to fix on characters." In 1843, Professor de Koninck observed, that it was impossible to distinguish the Silurian *Stroph. rhomboidalis* from the Carboniferous *Lept. analoga*, and he united the two under a single denomination. In p. 389 of his 'British Palæozoic Fossils,' while alluding to *Lept. analoga*, Professor M'Coy remarks, that "the shell in the Middle and Upper Palæozoic rocks can scarcely be considered as a distinct species from *L. depressa* of the Lower Palæozoic strata, and of which it is only a variety, not separable when the extremes are compared, but generally

¹ According to Darwin, a muscle does not exist simply because it was created, but because a necessity for it existed originally, and having once come to be of general use, traces of it might remain (as a rudimentary organ) in after-times, when the creatures had ceased to use it.

recognisable as a distinct variety much in the same way as the Devonian variety *aspera*, of the Silurian *Spirigerina reticularis*, is usually distinguishable from the older varieties. The general characters of the species are exactly those of *Lept. depressa*, and the description given in the Lower Palæozoic section of this species will suit the present one in nearly all respects. The differences which strike an observer are, that the transverse wrinkles in the Lower Palæozoic *L. depressa* are usually from twelve to fifteen in number, but in this variety they are from fifteen to twenty, and the longitudinal striæ are, on an average, considerably coarser in *L. analoga* than in *L. depressa*." The last two observations are not, however, of much importance; for I possess examples of the Silurian and Devonian shell with as many wrinkles as may be counted upon the generality of Carboniferous specimens, nor does there exist that great difference in the quality of the longitudinal striæ. Professor M'Coy then goes on to observe, that as to the varieties named *Lept. distorta* by Sowerby (Carboniferous), and *Lept. nodulosa* by Phillips (Devonian), he has in the mountain limestone traced all the intermediate varieties to the more regular types, and no doubt exists in his mind as to their specific identity. It is therefore evident that, in external shape and character, it is hardly possible to distinguish the Silurian, Devonian, and Carboniferous shell, and that those little differences that are occasionally observable, such as number of wrinkles and coarseness of longitudinal striæ, may be due to local conditions which often slightly modify the size and appearance of the same species.

Now let us cast a glance at the interior of the Silurian and Carboniferous shell. In the interior of the valves no very important differences can be traced, and the only peculiarity I can perceive is, that the ridges margining the muscular scars are generally more elevated or produced (though not always so) in the Carboniferous specimens; and it appears to me, therefore, that by retaining the term *analoga* as a varietal designation for the Carboniferous form, we shall be following the views advocated by the greater number of palæontologists.

The variety *distorta*, which has prevailed in certain localities, can be viewed in no other light but as that of a malformation, in which the dorsal valve is generally more or less convex, and bending more or less rapidly inwards before becoming again inflected to follow closely the deflected prolongation of the ventral valve.

Loc. In England, the Carboniferous variety is common in the Lower Carboniferous limestone of Longnor, as well as in other Derbyshire localities: it has been collected at Bolland and the Craven and Wensleydale districts, in Yorkshire; in Carboniferous shales at Redesdale, Northumberland; also in the Middle Carboniferous limestone of Ronaldsway and Poolwash, Isle of Man.

In Scotland, it is found at Gare, in Lanarkshire, in limestone, at 239 fathoms below the "Ell Coal," and 343 at Waygateshaw; in Renfrewshire, near Thornliebank; in Stirlingshire, in the Campsie Main limestone and Corrie Burn beds.

In Ireland, it appears to occur in all the Lower Carboniferous strata, as well as in the

Mountain limestone division. It is not rare in the Carboniferous slate, in the parish of Ballyseedy, county Kerry. Mr. Kelly mentions Ring, Currans, Millecent, and Ballina county, among the Irish localities; the variety "*distorta*" being very abundant, especially in the county of Kildare.

It is also a common species in the Carboniferous rocks of many foreign countries, very large and fine examples occurring at Visé and Tournay, in Belgium.

The Silurian and Devonian localities will be mentioned in the monographs treating of the form belonging to those epochs.

Sub-Genus—STREPTORHYNCHUS, *King*. 1850.

The shells composing this sub-genus are closely related to *Strophomena*; they are usually semicircular-convex or concavo-convex, externally striated and interstriated; the ventral valve possessing a prolonged and oftentimes bent or twisted beak. (See Part IV, p. 29, of the present volume.)

Many are the so-termed species that have been described as occurring in the Carboniferous rocks of this and other countries, but so exceedingly variable are these shells, and so intimately do they all appear connected and linked together by intermediate and insensible graduations of shape, that it becomes most puzzling and difficult to determine how far we may be permitted to limit the extent of variation, or to determine what shapes ought to be separated or combined under a single species. Darwin considers "the term species as one arbitrarily given for the sake of convenience to a set of individuals closely resembling each other, and it does not essentially differ from the term variety, which is given to less distinct and more fluctuating forms; that the term variety again, in comparison with mere differential differences, is also applied arbitrarily and for mere convenience sake." And further on the same author observes, that "no one can draw any clear distinction between individual differences and slight varieties, or between individual differences or more plainly marked varieties and sub-species and species."¹ And how often are we not too prone to solve a difficulty in the way of identification, by at once cutting the Gordian knot, and arbitrarily fabricating a new species, without seeking to determine or to trace the connection of the specimen with some other form, of which it may be but a variety or mere difference in shape.

Hundreds of British and foreign specimens of Carboniferous *Streptorhynchus* have been assembled and carefully examined, but after much research and uncertainty from not finding characters of sufficient permanence to warrant the establishing of distinct species, I resolved (provisionally so, at least) to retain but one, of which *S. crenistria* (Phillips) may be considered the type, and to describe under separate heads, but with

¹ Darwin 'On the Origin of Species.'

varietal designations only, those few forms whose connection with the typical shape could not be entirely established; and by so doing I hope to concur with the views of those palæontologists who are not disposed to go so far as I feel inclined to do. No trouble has been spared in the selection and illustration of the most important and characteristic forms assumed by the species and its varieties, and many more intermediate shapes could have been figured, had space permitted.

STREPTORHYNCHUS CRENISTRIA, *Phillips*, sp. Pl. XXVI, fig. 1, Pl. XXVII, figs. 1—5 and 10? Pl. XXX, figs. 14—16.

SPIRIFER CRENISTRIA, *Phillips*. Geol. of Yorkshire, vol. ii, pl. ix, fig. 6, 1836.

— *SENILIS*. *Ib.*, fig. 5.

LEPTÆNA ANOMALA, *J. de C. Sow*. Min. Con., tab. dcxv, figs. 1^b (but not 1^a, d, e), 1840.

ORTHIS UMBRACULUM, var., *Portlock*. Report on the Geology of the County of Londonderry, Tyrone, and Fermanagh, pl. xxxvii, fig. 5, 1843.

— — *De Koninck*. Animaux Fossiles du Terrain Carbonifère de la Belgique, p. 222, pl. xiii, figs. 4—7, 1843.

— *QUADRATA?* *M'Coy*. Synopsis of the Characters of the Carb. Fossils of Ireland, pl. xx, fig. 18, 1844.

— *BECHER*. *Ib.*, pl. xxii, fig. 3.

— *COMATA*. *Ib.*, pl. xxii, fig. 5.

— *CADUCA*. *Ib.*, pl. xxii, fig. 6.

LEPTÆNA SHARPEI, *Morris*. Catalogue, p. 138, 1854.

STROPHALOSIA STRIATA, *Morris*. Catalogue, p. 155, 1854, (part). Min. Con., tab. dcxv, fig. 1^a only.

LEPTÆNA CRENISTRIA and *L. SENILIS*, *M'Coy*. British Palæozoic Fossils, pp. 450 and 452, 1855.

ORTHIS KEOKUK, *Hall*. Iowa Report, pl. xix, fig. 5, 1858.

— *ROBUSTA*. *Ib.*, pl. xxviii, fig. 5.

STREPTORHYNCHUS CRENISTRIA, *Dav*. Mon. of Scottish Carb. Brach., p. 32, pl. i, figs. 16—22, 1860.

Spec. Char.—Very variable in shape, transversely or longitudinally semicircular; hinge-line straight, slightly exceeding or somewhat shorter than the greatest width of the shell; cardinal angles rounded or prolonged with acute terminations; ventral area variable in width, flat, and divided by a fissure covered with a pseudo-deltidium; dorsal area linear. Ventral valve variable in its curves, slightly convex at the beak, flat in the middle, and partly concave near and at the margin, or more or less regularly convex throughout; beak straight, produced, and often twisted or irregularly inclined to one side. Dorsal valve moderately or extremely convex. Surface of both valves covered with numerous

strong, radiating, rounded striæ with flattened interspaces of variable width, partly occupied by one or two smaller striæ, the ribs and interspaces being, at the same time, closely intersected by fine concentric lines or striæ, giving to the longitudinal ones a crenulated appearance.

In the interior of the ventral valve, a strong hinge-tooth is situated on either side at the base of the fissure, and strengthened by small dental or rostral plates; the muscular impressions form a saucer-shaped depression, partially surrounded by a slightly elevated ridge; the adductor or oclcluser (A) occupies the central portion, and forms two small elongated depressions, separated by a slightly elevated mesial ridge, and on either side are the larger scars (R), apparently composed of two parts, the anterior or central being due to the divaricator, while the other or outer one would be produced by the ventral adjustor? In the interior of the dorsal valve, the cardinal process (J, to which were attached the divaricator muscular fibres, Pl. 27, fig. 6, 7) is composed of two testaceous projections; the socket plates are large, and partially united to the lower portion of the cardinal process. Under these, on the bottom of the valve, may be seen the quadruple impressions left by the oclcluser, and which occupy above one third of the length of the valve, and are arranged in pairs divided by a short rounded median ridge.

Dimensions and relative proportions very variable; some examples have attained or exceeded three lines in length, by four in width, the depth varying also from a few lines to about two inches.

Obs. Several palæontologists have already coincided in the belief that *S. senilis* is nothing more than a different state of *S. crenistria*, viz., in which the shell has attained an excessive depth or degree of convexity, accompanied by a very large area. Professor M'Coy justly states *S. Sharpei* to be an undoubted synonym; and he might have said as much of *O. Bechei*, for the so-termed species has been made out of a crushed imperfect cast or impression of the same derived from the Carboniferous slate of Whiling Bay, Younghall, Ireland, as may be seen from an inspection of the original specimen in Sir R. Griffith's collection. *O. caduca* is a small flattened valve of *S. crenistria*, or of var. *arachnoidea*?, the original specimen in Sir R. Griffith's possession being derived from a black Carboniferous slate at Rahoran, Fivemiletown, Ireland. *O. comata* is founded on a fragment of dorsal valve; for the original specimen in Sir R. Griffith's collection shows the cardinal process, although not represented in the 'Synopsis;' the striæ are also not so close and regular as in the Irish author's enlarged illustrations, but agree more with those of *S. crenistria*, to which the specimen should be referred; and I cannot help feeling somewhat surprised that any author could fabricate a species upon such insufficient material as the third part of single valve must naturally be. In his work on the 'Cambridge Palæozoic Fossils,' while describing *S. crenistria*, Professor M'Coy justly observes that "the striation is very variable, according to the state of preservation: in some the principal striæ, being nearly a line apart, and the intervening flat spaces having very distinct, longitudinal, fine lines, internally punctured, the middle one largest and crossed by fine, close, deep, irregularly transverse wrinkles; in

others, the intervening striæ nearly equal the principal ones in size, and the shell appears more closely and coarsely striated sub-alternately : but both extremes may be seen on the one specimen, and the differences are clearly the result of the loss of one or more layers of shell." I have also had the advantage of being able to examine typical examples of Professor Hall's *O. Keokuk* and *O. robusta*, which were kindly presented to me by Mr. Worthen, and am thus enabled to affirm that these American shells cannot be specifically distinguished from British varieties of *S. crenistria*.

For a long time I felt puzzled how to deal with a certain curious fragmentary ventral valve, figured by Mr. J. de C. Sowerby, in the 'Mineral Conchology,' under the designation of *Leptæna anomala* (tab. 615, fig. 1, *b*), and which I have also represented in Pl. XXX, fig. 15. This shell was subsequently referred by Messrs. Salter and Morris to the genus *Strophalosia*, and united with it under the same denomination was *Productus striatus*; but here a double error has been committed, for the shell in question is neither a *Strophalosia*, nor does it belong to *Productus striatus*, which is an entirely different species, although so confounded likewise by Mr. J. de C. Sowerby. Having received from Mr. Burrow some curiously shaped examples of *Strept. crenistria*, (Pl. XXX, fig. 14), I at once perceived that *Lept. anomala* was no other than a malformation of Phillips's *S. senilis*, and consequently a *Streptorhynchus*, while the *Mytilus striatus* of Fischer belongs to the genus *Productus*. *O. quadrata* was created for a very small imperfect ventral valve of a *Streptorhynchus*, which looks very like a young *S. crenistria*; and the shell, such as it is, belongs to Sir R. Griffith, and is said to have been found in calp at Ballintrillick, Bundoran, Ireland. Its striation is exactly similar to that of *crenistria*, and to which it is referred at least provisionally, the material being too imperfect to admit of its being regarded as a well made-out species. Such are some of the undoubted synonyms of Phillips's species, and to which I would have added others, but for the reasons already given.

S. crenistria appears to have had a very extended vertical range, and is recurrent from the Devonian if not Silurian period? In the Carboniferous rocks, it is found in all the stages, from the lowest beds (such as the Lower Carboniferous Red and Yellow Sandstone of Kildress) up to the highest beds above the Mountain or Carboniferous Limestone. It is also a far-spread species, having been found in various parts of Europe, America, Asia, and Australia, everywhere assuming the same shape and variety.

In England, it occurs at Bolland, Kendal, Settle, the Isle of Man, &c.; in Scotland, at Bowertrapping, three miles south of Dalry, and in many localities in Lanarkshire, Renfrewshire, Dumbartonshire, Ayrshire, &c. It was figured by David Ure, in his 'History of Rutherglen and Kilbride' (pl. xiv, fig. 19), as far back as 1793. In Ireland, it occurs in many localities; among which may be mentioned Hook, Bundoran, Ballyduff, Millecent, &c.

In Belgium, it is found at Visé and Tournay, &c. In America at Keokuk, Iowa;

Warsaw, Nauvoo, St. Clair county, Illinois, &c. In India, at Moosakhail, &c., in the Punjab. It was found also in Spitzbergen, and in Australia, &c., &c.

VAR. A.—STREPTORHYNCHUS ARACHNOIDEA, *Phillips*, sp. Pl. XXV, fig. 19—21, Pl. XXVI, fig. 2, 3, 4 (lower figs.), 5, 6.

SPIRIFER ARACHNOIDEA, *Phillips*. Geol. Yorks., vol. ii, pl. xi, fig. 4, 1836.

ORTHESINA PORTLOCKIANA, *Semenow*. Ueber die Fossilien des Schlesiens Kohlenkalkes, pl. ii, fig. 1, 1854.

ORTHIS ARACHNOIDEA, *De Verneuil*. Geol. of Russia, vol. ii, pl. x, fig. 18, 1845.

Professor Phillips describes his *S. arachnoidea* as “very depressed, truncato-orbicular, hinge-line wide as the shell; striæ fine, sharp, and continually subdivided; upper valve convex, as in *S. resupinata*.” This description would certainly suit many specimens of true *S. crenistria*; but the figure in the ‘Geology of Yorkshire’ would not indicate a shell with a convex valve, such as that possessed by the Martins species, and was evidently intended for those very depressed varieties in which the valves were almost flat or but very slightly convex, one of them being even at times a little concave from the middle to the margin, as will be found represented in our Pl. XXV, fig. 19—21; Pl. XXVI, fig. 2, 3, 4. Such, at any rate, is the shell we can conceive as having been intended for *S. arachnoidea*. The area in this is narrow, while the striation is entirely similar to what we have already described. This variety or variation in shape of *S. crenistria* generally occurs in the same localities where the more convex forms are met with.

Professor Phillips mentions Stradon, Haltwhistle, Allenheads, near Heskell Newmarket. It is found also at Rutchough, and other places in Northumberland; in Scotland, in the localities already enumerated; while in Ireland, it occurs at Curragh, Ardmore, Kildare, Kildress, &c., &c.

VAR. B.—*S. KELLII*, *M'Coy*. Pl. XXVII, fig. 8.

ORTHIS KELLII, *M'Coy*. Synopsis of the Characters of the Carboniferous Fossils of Ireland, p. 124, pl. xxii, fig. 4, 1844.

In shape, this species or variety? is marginally semicircular and slightly indented in front, the hinge line being a little shorter than the greatest width of the shell. Ventral area narrow, and divided by a triangular fissure covered by a pseudo-deltidium. The

ventral valve is slightly concave, the beak alone presenting a small convexity; while the dorsal one is moderately convex, with a mesial furrow or depression. The surface of both valves is closely covered with numerous radiating, imbricated striæ, a smaller one or two intervening between the larger, as in *S. crenistria*. The typical specimen measured, length $19\frac{1}{2}$, width $28\frac{1}{2}$, depth 5 lines.

Professor M'Coy has stated that his species "seems to be constantly distinguished from *O. crenistria*, by its deep rounded mesial furrow, which indents the frontal margin;" but it is not always more convex than *S. crenistria*, nor are the angles in the last always acute, for many examples had them rounded, as in *S. Kellii*. It is quite true that the striation is so variable a character as to be of little use in specific distinctions, in the British species of *Streptorhynchus*; but, at the same time, I cannot allow that, in all the examples of *S. Kellii* that have come under my observation, the striation was finer, closer, or more equal than is commonly the case with *S. crenistria*, although such is the case in many individuals.

In England, *S. Kellii* has been found in the Black Rock, Clifton. In Scotland, it occurs in Ayrshire. In Ireland, at Monaghan; Annghilla, three miles south-west of Ballyganty in Tyrone, &c.

VAR. C.—*S. CYLINDRICA*, M'Coy. Pl. XXVII, fig. 9.

ORTHIS CYLINDRICA, M'Coy. Synopsis of the Characters of the Carboniferous Fossils of Ireland, p. 123, pl. xxii, fig. 1, 1844.

Almost circular, hinge-line shorter than the greatest width of the shell, with rounded cardinal angles: area triangular, not very wide; fissure covered by a pseudo-detidium. Ventral valve convex at the beak, concave from near the middle to the margin; dorsal valve very convex, almost geniculated. Surface covered with numerous radiating striæ, of which two or three smaller ones intervene between the larger ones. Of this beautiful species or variety (?) I have never been able to obtain the sight of any other besides the type, which measures eighteen lines in length, by twenty-one and a half in breadth, and ten in depth.

Professor M'Coy observes that, in this species, the striation is similar in character to that of *O. crenistria*, *O. Kellii*, and *L. englypha*, but that the form at once distinguishes it from every known species.

It is at all times hazardous to make a new species upon the inspection of single examples; and as my knowledge in the present instance does not extend beyond the one figured in the 'Synopsis,' I dare not venture to conjecture too closely as to its probable affinities or variations in shape. The original example in Sir R. Griffith's collection is said to have been found in Arenaceous Limestone at Castle Espie, Comber, Ireland.

VAR. D.—*S. RADIALIS*, *Phillips*. Pl. XXV, figs. 16—18.

SPIRIFER RADIALIS, *Phillips*. Geol. of Yorks., vol. ii, pl. xi, fig. 5, 1836; and *Dav.*,
Mon. of Scottish Carb. Brachiopoda, pl. i, figs. 24,
25, 1860.

Shell variable in shape; transversely or longitudinally semicircular; hinge-line usually shorter than the greatest width of the shell. Dorsal area of moderate width; fissure closed by a pseudo-deltidium. Valves moderately convex, the dorsal one being the deepest, with sometimes a slight depression near the front of the ventral one. Surface covered with strong radiating striæ, with intervening smaller ones, crossed by imbricated lamellæ and deep concentric lines or interruptions of growth.

This species or variety (?) does not appear to have attained the large dimensions of *S. crenistria*, but the following average measurements may be given:

Length 17, width 21, depth 7 lines.

„ 16, „ 15, „ 6 „

The interior details do not appear to differ from those of *S. crenistria*; but on a young specimen from Gare there appeared to exist a small circular foramen at the extremity of the beak, similar to what we see in some species of *Strophomena*; the aperture does not, however, exist in full-grown individuals, and thus shows that the animal could dispense with its temporary moorage.

The striæ differ also much in different specimens, from the larger ones being either closer or more widely separated, two or four smaller ones occupying the interspaces. It must be, however, observed that it is difficult at times to distinguish certain individuals of *S. radialis* from others of *crenistria*.

Professor Phillips mentions Florence Court, near Enniskillen, as the locality whence his type was obtained; but the figure in the 'Geology of Yorkshire' is very incomplete, and drawn from a crushed specimen. Good examples have been collected at Whatley, near Frome, in Somerset; at Gare and Middleholm, in Lanarkshire, Scotland; and at Middleton, in Ireland.

Genus—ORTHIS.

The genus *Orthis* forms a well-characterised group, especially numerous and abundant in the Silurian and Devonian systems, is considerably reduced during the Carboniferous period, to appear no longer (?) in subsequent stages. Four species alone have been hitherto discovered in the Carboniferous rocks of Great Britain.

ORTHIS RESUPINATA, *Martin*, sp. Pl. XXIX, figs. 1—6. Pl. XXX, figs. 1—5.

CONCHYLIOLITHUS ANOMITES RESUPINATUS, *Martin*. Petrif. Derb., tab. xlix, figs. 13, 14, 1809.

TEREBRATULA RESUPINATA, *Sow*. Min. Con., tab. 325, Feb., 1822.

SPIRIFERA RESUPINATA, *Phillips*. Geol. Yorks., vol. ii, pl. xi, fig. 1, 1836.

— *CONNIVENS*. *Ib.*, fig. 2.

— *RESUPINATA*, *V. Buch*. Mém. Soc. Géol. de France, vol. iv, pl. x, fig. 32, 1840.

ORTHIS RESUPINATA, *De Koninck*. Description des Animaux Fossiles de la Belgique, pl. xiii, fig. 9, 1843.

ATRYPA GIBBERA, *Portlock*. Report on the Geology of Londonderry, Tyrone, and Fermanagh, pl. xxxviii, fig. 1, 1843.

ORTHIS LATISSIMA, *M'Coy*. Synopsis of the Carb. Limest. Fossils of Ireland, pl. xx, fig. 20, 1844.

— *GIBBERA*. *Ib.*, pl. xviii, fig. 9.

— *RESUPINATA*, *Dav.* 'Introduction,' pl. vii, fig. 135, 1853.

— — *M'Coy*. British Palæozoic Fossils, p. 449, 1855.

— — *Dav.* Scottish Carb. Brach., p. 28, pl. i, figs. 11, 12, 13, 1860.

Spec. Char. Shell transversely oval or elliptical; valves convex, sometimes gibbous; hinge-line straight, much shorter than the greatest width of the shell, with rounded cardinal angles. Dorsal valve generally the deepest, regularly and evenly convex, or slightly flattened and depressed along the middle to the front, area narrow. Ventral valve variable in its curves, moderately convex throughout, or at the rostral portion only, becoming flattened or slightly concave near the lateral and frontal margins. The frontal margin presents a uniform or undulated curve, indenting to a lesser or greater extent the margin of the opposite valve. Beak small and moderately incurved; area triangular, with an open fissure. Exteriorly, the valves are closely covered with numerous fine, thread-like, rounded, radiating striæ, which increase in number by interstriation and bifurcation at variable distances from the beaks, and at intervals the striæ themselves augment in thickness and prominence, producing small, hollow, thread-like, tubular spines, which become more numerous towards the margin. The intimate shell structure is perforated by innumerable canals, of which the exterior orifices, in the shape of minute punctures, cover the entire surface of the valves.

In the interior of the ventral valve, the dental plates extend to some distance along the bottom of the shell, and between these a small rounded or angular ridge divides the muscular scars, which thus form two elongated depressions margined on their outer sides by the prolonged basis of the dental plates. The adductor or occlusor leaves a small, not always clearly defined impression on either side of the mesial ridge, and it is probable

that the larger impressions, termed divaricator (R), in our figures of this species (as well as of *O. Michelini*), is apparently composed of two parts, the anterior or central being the cardinal or divaricator, while the other, the posterior or lateral (which is parallel), may belong to the ventral adjuster?

In the dorsal valve, the fissure is almost entirely occupied by a moderately produced shelly prominence or cardinal process, to which were no doubt affixed the divaricator muscular fibres. The inner socket walls are somewhat prolonged under the shape of projecting laminæ, and to the extremity of which free spiral arms may perhaps have been attached (?); while under this shelly process a longitudinal ridge, with a wide, flattened space on either side, separates the quadruple impressions of the adductor or occlusor muscles; these last producing two oval-shaped depressions, placed obliquely one above the other, and separated by lateral elevations branching from the central ridge. Vascular impressions and ovarian markings are at times clearly observable in the interior of both valves.

Dimensions and degree of convexity very variable two extremes have measured—

Length, 32; width, 41; depth, 21 lines (the largest example I have seen).

„ 16; „ 17½ „ 16 „

Obs. *O. resupinata* is a common, well-known, and widely spread Carboniferous shell. Its exterior appearance has been often described and illustrated, but not always properly understood. In shape it is subject to considerable variation, and hence the specific denominations of *resupinata*, *connivens*, *gibbera*, and *latissima*, which appear to Mr. Morris and myself to have been applied to what we must regard as different states of a single species; and in my plates will be found represented some of the most remarkable shapes. The striation is also finer in some specimens than in others; and certain examples show, more than others do, the small drop-like elevations from which originate the little thread-like spines, which are generally broken close to the surface of the valves in a large number of specimens.

Interiorly, some unimportant variation in detail may likewise be occasionally observed and which I have endeavoured to illustrate.

In England, *O. resupinata* abounds in the Carboniferous limestone and shales of many localities, such as at Greenhow Hill; Hawes, Otterburn; at Dovedale, in Derbyshire; the Isle of Man; Lowick, Northumberland; Settle, Malham Moor, Withgell, Yorkshire; at Ulverston, Bolland, &c.

In Ireland, it is found at Tyrone, St. John's Point, Dunkineely, Cornacarrow, Enniskillen; Cruiceroth, near Drogheda, County Meath; Little Island; Cornagrade, Bundoran, Cookstown, Millecent, &c.

In Scotland, it occurs at Gare, Raes Gill, Middleholm and Brockley, near Lesmahago, Capel Rig, East Kilbride, &c., in Lanarkshire; in Ayrshire, at Auchenskeigh, near Dalry, West Broadstone, Beith, &c; in Dumbartonshire, at Castlecary; in Stirlingshire, at Balglass Burn, as well as in the Campsie Main Limestone and Corrieburn beds. It occurs also in Midlothian and other Scottish counties.

On the Continent, it is not rare at Visé and Tournay, in Belgium, &c.

ORTHIS KEYSERLINGIANA, *De Koninck*. Pl. XXVIII, fig. 14.

ORTHIS KEYSERLINGIANA, *De Koninck*. Description des Animaux Fossiles qui se trouvent dans le Terrain Carbonifère de Belgique. p. 230, pl. xiii, fig. 12, 1843.

Spec. Char. Shell transversely oval or sub-quadrate, with rounded angles; ventral valve convex, and much deeper than the dorsal one, with a deep longitudinal median sinus or groove, which extends from the extremity of the incurved umbonal beak to the front, this valve being likewise the longest and largest, on account of the umbonal beak being more elevated than the level of the beak and area of the dorsal one; area narrow. Dorsal valve straight, flattened, and sometimes slightly concave from the extremity of the beak to the front, the lateral portions sloping gently on either side; area triangular, flattened, and bent backwards; beak small, angular, slightly convex, and on a level with the area; fissure triangular, open; margin moderately flexuous. Exteriorly, each valve is covered with numerous thread-like, rounded, radiating striæ, which increase in number by the means of numerous interstriations and bifurcations from the extremity of the beak to the front; the striæ at intervals augmenting in thickness as well as projection, and giving rise to small thread-like spines (broken close to the surface in the generality of specimens). Numerous concentric lines of growth are also observable on the valves, which are likewise perforated by minute tubuli. Interior unknown.

Two specimens have measured—

Length 11, width $12\frac{1}{2}$, depth $6\frac{1}{2}$ lines.

„ 8, „ 10, „ 6 „

Obs. This interesting and well-marked species was first brought to my notice as British by Professor de Koninck, who had received a specimen from England, but without locality; and it was only after some research that I learnt that Mr. Burrow had found several examples in the Carboniferous limestone of Settle, in Yorkshire, this being also the only British locality, with which I am at present acquainted, wherein the shell has been discovered. *O. Keyserlingiana* cannot be confounded with *O. resupinata*, on account of its peculiar and different shape, although the striation is very similar in both. In Belgium, it has been found occasionally at Visé.

ORTHIS MICHELINI, *L. Eveillé*. Plate XXX, figs. 6—12.

TEREBRATULA MICHELINI, *L'Eveillé*. Mém. de la Soc. Géol. de France, vol. ii, p. 39, pl. ii, figs. 14—17, 1835.

SPIRIFERA FILIARIA, *Phillips*. Geol. of Yorks., vol. ii, pl. xi, fig. 3, 1836.

- ORTHIS MICHELINI, *De Koninck*. Desc. des Animaux Fossiles du Terrain Carb. de la Belgique, pl. xiii, figs. 8 and 10^c, 1843.
- DIVARICATA. *M'Coy*. Synopsis of the Carb. Fossils of Ireland, pl. xx, fig. 17, 1844.
- CIRCULARIS. *Ib.*, fig. 19.
- MICHELINI. *De Verneuil et De Keyserling*. Geol. of Russia, vol. ii, pl. xii, fig. 7, 1845.
- — *Semenow*. Ueber des Fossilien des Schlesiens Kohlenhalkes, tab. iii, fig. 11, 1854.
- — *M'Coy*. British Palæozoic Fossils, tab. iii, fig. 11, 1854.
- MICHELINI var., BURLINGTONENSIS, *Hall*. Iowa Report, pl. xii, fig. 4, 1858.
- — *Dav*. A Monograph of the Carb. Brach. of Scotland, pl. i, figs. 7—10, 1860.

Spec. Char. Shell depressed, almost circular or subtrigonal, as wide or wider than long, with greater width near the frontal margin, this last assuming a gentle outward or slightly inward curve; hinge-line much attenuated, not above one third the width of the shell, sometimes less; ventral area small, but rather larger than that of the opposite valve, and divided by a fissure which is almost entirely filled up by the cardinal process of the dorsal valve. Ventral valve either moderately convex, with a slight depression commencing about the middle and extending to the front, or flattened throughout with the exception of the beak, which is small, slightly incurved, and prominent. Dorsal valve, moderately and uniformly convex, or gently depressed towards the front. Surface of both valves closely covered with thread-like, radiating, rounded striæ, which increase in number by means of numerous interstriations and bifurcations, while from all the little ribs hair-like hollow spines project and become more closely packed towards the margins. Intimate shell structure perforated by small canals, of which the external orifices, under the shape of punctures, cover the entire surface of the valves.

In the interior of the dorsal valve, the cardinal process is situated between two projecting laminae (which perhaps afforded attachment to the spiral arms) while under this shelly process a narrow median longitudinal ridge separates the quadruple impressions of the adductor or oclcluror muscle; these last producing on either side two oval-shaped depressions, one placed above the other, and separated by lateral elevations branching from the central ridge.

In the interior of the ventral valve, the dental plates extend to some distance along the bottom of the shell, and between these are situated the muscular impressions. At the base of the fissure, and between the dental plates, may be observed a horizontally striated impression, which may perhaps be due to the pedicle muscle; under this a smaller median oval depression was produced by the oclcluror, while the larger elongated depressions on each side of this are apparently formed of two parts, the anterior or one close to the oclcluror being the cardinal or divaricator, while the other, the posterior or lateral, which is parallel, may belong to the ventral adjustor? Ovarian and vascular impressions are also visible.

Dimensions variable; three examples have measured—

Length 15, width $16\frac{1}{2}$, depth 5 lines.

„ 15, „ 15, „ 6 „

„ 11, „ 11, „ 6 „

Obs. *O. Michelini* is a common and far-spread Carboniferous species, always recognizable, and easily distinguished from *O. resupinata* and *O. Keyserlingiana* both by external shape and by interior differences, which last are evinced in the narrowness of the median ridge, and less inclined slope of the adductor or occlusor muscular impressions; while in the dorsal valve the space occupied by the adductor, divaricator, and ventral adjustor muscles is wider than in *O. resupinata*. There is also a singular impression, marked N in fig. 9, which is with some uncertainty attributed by Mr. Hancock to the pedicle muscle. The striation in *O. Michelini* differs also from that of *O. resupinata* and *O. Keyserlingiana* by the absence of that peculiar dilatation of some of the striæ before the occurrence of a spine-like projection, and the remarkable abrupt diminution of the swollen ridge beyond the spine, which produces those elongated drop-like mark, so visible over the surface of the last-named species. Professor De Koninck, who in 1843 first noticed the spiny investment of the shell under description, expressed the opinion that the dorsal valve was alone so adorned; but a careful examination of many specimens has convinced me that spines existed on both, although perhaps more numerous spread on the dorsal valve. The spines were likewise more abundant on some examples than on others, nor do they seem to have anywhere exceeded about a quarter of an inch in length.

Orthis Michelini appears also to have varied less in shape than the preceding species; the shortness of the hinge-line is, however, in some specimens very remarkable.

O. Michelini abounded where it occurred, and especially so in certain shales at the top of the Mountain Limestone, such as at Clattering Dykes, on the middle of Malham Moor, in Yorkshire; nor is it rare in the Mountain or Carboniferous Limestone of Settle, Bolland, Fountain Fell, the Isle of Man, &c.

In Ireland, it occurs in the Carboniferous Limestone and shales at Lisnapaste, Little Island, Millecent, Ballyduff, Bruckless, Malahide, Old Leighlin, &c. It may also be collected by millions (in the condition of internal casts and impressions) in the calciferous states of Ballyseedy, County Kerry.

In Scotland it is also very plentiful in certain localities, such as at Gateside, near Beith, where detached valves occur by thousands in the same stratum of shale whence David Ure collected his specimens of the species.¹ In Lanarkshire, it occurs at Langshaw Burn, Brockley, and Middleholm, near Lesmahago, Auchentibber, Calderside, and Phillips-hill, High Blantyre; Capel Rig, East Kilbride, &c. In Renfrewshire, at Orchard Quarry Thornliebank; Barrwood and Howood, near Paisley. In Ayrshire, at Roughwood, West Broadstone, and Treehorn, near Beith, &c. In Stirlingshire it is found in several stages; and occurs also in Dumbartonshire, Fifeshire, &c.

¹ David Ure appears to have been the first naturalist who figured this shell in Great Britain; for figs. 13 and 14 of the fourteenth plate of the 'History of Rutherglen,' published in 1793, evidently belong to the species under description.

In Belgium, it is common in the limestone and shales of Tournay; but rarer at Visé. In Russia, at Cosatchi-datchi, &c. While in America it has been collected at Burlington, Iowa; Quincy, Illinois; Hannibal, Missouri, &c.

ORTHIS? ANTIQUATA, *Phillips*. Plate XXVIII, fig. 15.

TEREBRATULA ANTIQUATA, *Phillips*. Geol. Yorks., vol. ii, pl. xi, fig. 20, 1836.

RHYNCHONELLA ANTIQUATA, *Morris*. 'Catalogue,' p. 146, 1854.

Spec. Char. Somewhat elongated oval; hinge-line straight, shorter than the greatest width of the shell; ventral valve deep and convex, but flattened towards the front; beak small, incurved; area narrow, with an open triangular fissure (?). Dorsal valve shallow, and divided into three lobes, of which the two largest diverge from the umbone to the lateral margins, the third or the less produced forming a small median elevation, originating near the middle, and extending to the front, where the valve assumes a somewhat triundate margin and appearance. Surface smooth; length 4, width 3, depth $2\frac{1}{2}$ lines.

Obs. Of this little shell I have seen but one example—that described and figured by Professor Phillips, and which is stated to have been obtained at Bolland, and now forming part of the Gilbertsonian collection in the British Museum. All endeavours to procure the sight of another example have proved unavailing; so that my observations have been confined to the examination and description of the original type, which looks more like a small *Orthis* than a *Terebratula* or *Rhynchonella*, and it is therefore here at least provisionally located under the genus *Orthis*. Professor Phillips describes his species in the following words:—"a very singular, small Brachiopodous shell (perhaps *Producta*) of an oval figure; lower valve convex; upper plane, with two diverging convexities; hinge-line straight." Upon such insufficient material, the species itself can only be admitted as provisional.

Family—PRODUCTIDÆ.

The PRODUCTIDÆ have been divided into four groups, viz., *Productus*, *Aulosteges*, *Strophalosia*, and *Chonetes*; but they all appear to bear so natural and indeed so intimate a relation towards each other, that it is very questionable whether the last three should be considered more than simple sub-genera or modifications of *Productus*; and this is also the opinion of Professor de Koninck, to whom science is indebted for a valuable monograph of the many forms of which this family is composed.

All the species at present known are restricted to the limits of a portion of the Palæozoic period. No British examples of Carboniferous *Strophalosia* or *Aulosteges* have

been hitherto recorded ; but a few forms of those sub-genera occur in equivalent rocks of other countries, such as Belgium and India. In all British species of *Productus* and *Chonetes*, the shell is more or less concavo-convex, oval, semi-oval, or angular, and generally auriculated ; the hinge-line is straight and strong, with or without teeth and sockets for the articulation of the valves. All well-authenticated species of *Productus*, hitherto examined, have shown themselves to be edentulous, but whether this character was general and without exception may remain a question for further consideration ; anyhow, the dorsal valve must have turned on its long hinge-line with as much precision as in *Chonetes*, which possessed regularly articulating teeth. It has been often asserted and believed that *Productus* might be distinguished from its sub-genera by the total absence of an area ; and although this is the prevalent character of the genus, still in certain species, such as *P. sinuatus*, a perfectly developed area is generally present in the ventral valve. There exists also an occasional tendency to the formation of hinge-area in several species, as may be seen, for example, in the remarkable example of *P. semireticulatus* of which a representation is given in Pl. XLIII, fig. 5.

All species of *Chonetes* at present known have, in addition to the regular articulation, an area in each valve, this being larger in the ventral than in the dorsal one, which is also divided by a fissure, more or less arched over by a pseudo-deltidium, the cardinal process of the opposite valve filling up and effectually closing any portion that might have otherwise remained uncovered.

The external surface in *Productus* varies according to the species ; in some, it is almost smooth, in others longitudinally and finely striated or coarsely costated, as well as intersected by numerous concentric wrinkles or lines of growth. All the species appear to have been furnished with tubular spines ; in some forms they are small, delicate, and so closely packed as to conceal every portion of the shell, with the exception of the area ; while in others they are irregularly scattered, and chiefly confined to the auriculate portions of the valves. In certain species, the spines exceeded by four or five times the length of the shell ; and while some were almost as delicate as the hair of one's head, others exceeded a line diameter ; the dimensions of the shell having nothing to do with that of the spine, for in some small species these were few and large, while the reverse has occasionally been found to be the case with species of the largest dimensions.

Chonetes differs also somewhat from *Productus* by the manner in which its spines are disposed along the cardinal edge, these last sloping outwardly, and increasing in length as they approach the extremities of the hinge-line ; but in many species, in addition to these, there existed on the surface of the valves small spines, disposed as in *Productus*.

The intimate shell-structure has been described by Dr. Carpenter to be perforated, and that, where the shell is furnished with spines, the perforations are continued into them, and that such passages are of more than average dimensions. In *Productus* the internal surface of the dorsal valve is more or less convex, and presents in the middle of

the hinge-line, a prominent bilobed or trilobed projection or cardinal process (J),¹ its upper surface is often striated, and affords attachment to the cardinal or divaricator muscles (R). Under this a narrow longitudinal ridge generally extends to about half (or more) of the length of the valve, and on either side are seen the ramified or dendritic impressions, which we consider to be attributable to the adductor or posterior and anterior oclusor muscle (A), but which are often situated so close to each other, on either side of the mesial ridge, as to render the quadruple attachment not so distinct as could be desired; they are, however, well defined in *P. longispinus*, and in some other species. Outside, and in front of these, are the two "reniform impressions" (x). Their surface is generally smooth, and bordered by ridges, which after dividing the oclusor muscles proceed in an outward, oblique, or almost horizontal direction; then turning abruptly backwards, they terminate at a short distance from their origin. There exists also, in many species, but not in all, two prominences (w), one on each side of the median ridge, and close to the base of the muscular scars; they are very apparent in *Productus*, but not observable in *Chonetes*.

The internal surface of the valves (in all the family) is covered with innumerable granulations, of which some have been thought by Mr. Hancock to have been "probably produced by the muscular bands, which retracted the margin of the mantle." I will now describe the internal appearances observable on the concave surface of the larger or ventral valve. A narrow mesial ridge, originating under the extremity of the beak, separates two large, elongated, ramified or dendritic impressions (A), which have in all probability been produced by the adductor or oclusor muscle, although otherwise referred by some Palæontologists. In advance of the larger scars, we sometimes perceive smaller impressions closely connected with the larger ones above described (E), and which were in all probability produced by a portion of the oclusors themselves. On either side of the adductor or immediately under there exist two deep, longitudinally striated, sub-quadrate impressions, which are due to the cardinal or divaricator muscles (R). I have in vain, hitherto, sought for impressions referable to the adjustor muscles; but as no peduncular aperture existed, such muscles may be supposed not to have existed: however, as the valves in the species hitherto known of *Productus* possessed no teeth or sockets, and therefore are not strongly articulated, as in the *Terebratulidæ*, it is not impossible that the adjustors may have been so arranged as to keep the valves adjusted to each other, and that they thus acted as a substitute for a hinge.

The only point remaining to be here noticed in connection with the interior of this valve are the deep concave, often sub-spinal, depressions (L), visible in some species, such as *P. giganteus*, *P. humerosus*, &c., and which were hollows no doubt occupied by the spiral arms, for it would seem impossible to conjecture otherwise, how they had originated. Similar hollows could not of course be expected to be present in those species in which

¹ See Pl. XXXVII, figs. 1—4.

the shell did not possess a sufficient thickness, as they never influenced the regular curve or convexity of the exterior of the valve. In all the *PRODUCTIDÆ* we therefore find muscles destined to open and close the valves, as well as evidence that they possessed spiral arms, and which have been justly, I think, supposed to be brachial appendages, which subserved at once the function of gills and of sustentation.

In *Chonetes*, the muscular impressions are somewhat similar to those of *Productus*, but of more often comparatively smaller proportions, as may be perceived by a glance at the figures I have given of both.

The determination and arrangement of the British Carboniferous species of *Productus* and *Chonetes* has demanded a lengthened examination, for much confusion still existed among the synonyms, notwithstanding the able and valuable researches of Professor de Koninck. Through the kindness of several friends, I have been enabled to study the original types of the larger number of species, as well as a very extensive series of specimens; and although I have rejected a great number of so-termed species, and been able to add several others new to Great Britain, I should still urge further research upon these very interesting shells, as it has not been always possible to determine the specific claims of some among them with sufficient accuracy.

After much examination, and in some cases much uncertainty, the following twenty-eight species have been retained, and which may be arranged in the following three groups.¹

- | | | |
|--|-----|--------------------------------------|
| | 1. | <i>Productus striatus</i> , Fischer. |
| | 2. | — <i>giganteus</i> , Martin. |
| | | var. <i>hemisphæricus</i> , Sowerby. |
| | 3. | — <i>latissimus</i> , J. Sowerby. |
| | 4. | — <i>Cora</i> , D'Orbigny. |
| | 5. | — <i>semireticulatus</i> , Martin. |
| | 6. | — <i>costatus</i> , Sowerby. |
| | | var. ? <i>muricatus</i> , Phillips. |
| 1. <i>Striati</i> , or <i>Semireticulati</i> | 7. | — <i>longispinus</i> , Sowerby. |
| | 8. | — <i>sinuatus</i> , De Koninck. |
| | 9. | — <i>humerosus</i> , Sowerby. |
| | 10. | — <i>Margaritaceus</i> , Phillips. |
| | 11. | — <i>undatus</i> , DeFrance. |
| | 12. | — <i>arcuarius</i> , De Koninck. |
| | 13. | — <i>carbonarius</i> , De Koninck. |
| | 14. | — <i>ermineus</i> , De Koninck. |
| | 15. | — <i>proboscideus</i> , De Verneuil. |
| | 16. | — <i>Wrightii</i> , Davidson. |
| | 17. | — <i>tessellatus</i> , De Koninck. |

¹ Those groups and species most nearly related have been connected by the means of a brace. It is difficult, with words, to explain the exact contour, or shape, of such variable shells as the *Producti*; but

2. <i>Spinosi</i>	{	18. <i>Productus scabriculus</i> , Martin.
		19. — <i>pustulosus</i> , Phillips.
		20. — <i>fimbriatus</i> , Sowerby. var. <i>laciniatus</i> , M'Coy.
		21. — <i>punctatus</i> , Martin. var. <i>elegans</i> , M'Coy.
		22. — <i>aculeatus</i> , Martin.
3. <i>Sublævi</i>	{	23. — <i>Youngianus</i> , Davidson.
		24. — <i>Keyserlingianus</i> , De Koninck.
		25. — <i>spinulosus</i> , J. Sowerby.
		26. — <i>mesolobus</i> , Phillips.
		27. — <i>plicatilis</i> , Sowerby.
		28. — <i>sublævis</i> , De Koninck.

PRODUCTUS STRIATUS, *Fischer*. Plate XXXIV, figs. 1,—5.

PRODUCTUS COMOIDES, *Dillwyn*. An Index to the Hist. Conch. of Lister, p. 24 (not of Sow.), 1823.

MYTILUS STRIATUS, *Fischer*. Oryct. du Gouv. de Moscou, p. 181, pl. xix, fig. 4, 1830.

PINNA INFLATA, *Phillips*. Geol. of Yorkshire, vol. ii, pl. vi, fig. 1, 1836.

PECTEN TENUISSIMUS, *Eichwald*. Bullet. Scient. de l'Acad. de St. Petersburg, vii, p. 86, 1840.

LIMA WALDAICA, *V. Buch*. Kersten's Archiv für Min. Geogn., &c., p. 60, 1840.

LEPTÆNA ANOMALA, *J. de C. Sow*. Min. Conch., vol. vii, pl. 615, fig. 1, *a, c, d* (not 1 *b*, which belongs *Streptorhynchus crenistria*, var. *senilis*), 1841.

PRODUCTUS LIMÆFORMIS, *V. Buch*. Abhand. der Königl. Akad. der Wissens. zu Berlin, aus dem Jahre, Theil. i, p. 22, pl. i, figs. 4, 5, and 6, 1841.

— STRIATUS, *De Kon*. Desc. des Anim. Foss. du Syst. Carb. de Belgique, pl. vi, fig. 10, and pl. viii bis, fig. 4, 1843.

— — *De Verneuil*. Russia and the Ural Mountains, vol. ii, p. 254, pl. xvii, fig. 1, 1845.

— — *De Keyserling*. Reise in das Petschoraland, pl. iv, fig. 8, 8*a*, and 8*b*, and pl. v, fig. 1, 1846.

— — *De Kon*. Mon. du genre Productus, pl. i, fig. 1, *a—d*, 1847.

STROPHALOSIA STRIATA, *Morris*. Catalogue, p. 155, 1854.

PRODUCTUS STRIATUS, *M'Coy*. British Pal. Fossils, p. 473, 1855.

Spec. Char. Shell thin, exceedingly variable in shape, and often irregular; usually much elongated, triangular, with acuminate beak and rounded front; or broad, transversely semicircular; hinge-line always shorter than the width of the shell, sometimes exceedingly so. Ventral valve moderately convex, rarely gibbous, without sinus; beak pointed, rarely a glance at the figures will, I trust, remove all uncertainty. In order not to unnecessarily burden the list of references, I have many times purposely omitted to allude to those catalogues or works in which the species are named, but not illustrated.

projecting beyond the hinge-line; ears small, flattened, and from which project numerous long slender spines; surface covered with fine, thread-like, waving, radiating striæ, which increase in number at variable distances from the beak by the interpolation of other striæ. Spines few in number, and irregularly scattered over the surface. Dorsal valve concave, following the curves of the opposite one, and similarly ornamented.

Dimensions very variable; three British specimens have afforded the following measurements:

Length 39, width 20 lines.

„ 41, „ 35 „

„ 20, „ 26 „

Obs. This species is very remarkable, on account of the various forms it is capable of assuming, and has consequently not only been attributed to seven different genera, but has received as many specific denominations. The shell and its history have been minutely described by Professor de Koninck, as well as by some other authors, but it was Lister who, in 1688, first noticed the shell, ‘Hist. sive Synops. Conch.,’ pl. 468, fig. 27; although it received its first specific denomination from Fischer de Waldheim in 1830, or shortly after. The shell is sometimes so very irregular in its shape as to be hardly recognisable, and although Professor M‘Coy states that he has seen some Irish specimens one foot in length by five inches in width, I have never observed any examples exceeding four inches in length. The space between the valves is also remarkably small, and in no case have I ever noticed an area in either valve. In 1840, Mr. J. de C. Sowerby confounded some specimens of the shell under description with a distorted imperfect valve of *Streptorhynchus crenistria*, var. *senilis*, and consequently erroneously described the species as possessing a large triangular hinge area. Mr. Morris has also fallen into the same mistake, for he classes Fischer’s species in the sub-genus *Strophalosia*; the reader is however referred to p. 126 of the present monograph for further information upon the subject. The spines are very numerous and closely packed upon the ears, Professor de Koninck having counted as many as twenty-four on each of the auriculate expansions in certain specimens, but that they are exceedingly rare on the surface of the shell. I have never seen any perfect interiors of either valve, but fragments have shown that the details are very similar to those of other species of the genus.

In England it occurs in the lower scar limestone of Settle, in Yorkshire; the lower carboniferous limestone, Park Hill, Longnor, in Derbyshire; the dark middle limestone of Lowick, Northumberland, as well as of the Isle of Man, &c. No specimen has been hitherto found in Scotland, and although Ardagh in Ireland is mentioned in Mr. Kelly’s list, I have seen no specimen. In Belgium it occurs at Visé. In Russia, in the valleys of Stolobenka and Prikcha (Valdai) in the Petschora, near Zvenigorod, &c. In the Punjaub (India), &c., &c.

PRODUCTUS GIGANTEUS, *Martin*. Plate XXXVII, figs. 1—4; Plate XXXVIII, fig. 1;
Plate XXXIX, figs. 1—5; Plate XL, figs. 1—3.

- ANOMITES GIGANTEUS, *Martin*. Petrif. Derb., pl. xv, fig. 1, 1809.
— CRASSUS, *Martin*. Ib., pl. xvi, fig. 2, 1809.
PRODUCTUS GIGANTEUS, *J. Sow*. Min. Con., vol. iv, pl. 320, Jan., 1822.
— HEMISPHERICUS, *J. Sow*. Ib., pl. 561, 1827.
PRODUCTA GIGANTEA, *Phillips*. Geol. of York., pl. viii, fig. 5, 1836.
— AURITA, *Phillips*. Ib., pl. vii, fig. 6, 1836.
— EDELBURGENSIS, *Phillips*. Ib., pl. vii, fig. 5, 1836.
LEPTENA VARIABILIS, *Fischer*. Oryct. du Gouv. de Moscou, p. 144, pl. xxi, 1837.
PRODUCTUS GIGAS oder GIGANTEUS, *Von Buch*. Abhandl. der Königl. Akad. der
Wissens. zu Berlin, aus dem Jahre, p. 19, 1841.
— COMOIDES, *Von Buch*. Ib., pl. i, figs. 1—3 (not Sow.).
PRODUCTA HEMISPHERICA, *D'Archiac* and *De Vern*. Trans. of the Geol. Soc. of
London, 2d series, vol. vi, p. 397, 1842.
PRODUCTUS GIGANTEUS, *De Koninck*. Animaux Foss. des Terr. Carb. de Belgique,
pl. vii, fig. 1, 1843.
— COMOIDES, *De Koninck*. Ib., pl. vii bis, fig. 1 (not Sow.).
LEPTENA MAXIMA, *M'Coy*. A Synopsis of the Characters of the Carb. Limest. of
Ireland, pl. xix, fig. 12, 1844.
PRODUCTUS STRIATUS, *E. Roberts*. Atlas Géologique des Voyages en Scandinavie et de
la Commission Scientifique du Nord, pl. xx, fig. κ, 1845
(non Fischer).
— GIGANTEUS, *De Verneuil*. Russia and the Ural Mount., vol. ii, pl. xvi, fig.
12, and pl. xvii, fig. 2, 1845; and *P. Edelburgensis*, ib.,
pl. xviii, fig. 2.
— — *De Koninck*. Mon. du genre Productus, pl. ii, fig. 1; pl. iii,
fig. 1; pl. iv, fig. 1; and pl. ix, fig. 8, 1847.
— — *M'Coy*. British Palæozoic Fossils, p. 463, 1855.
— — *Dav*. The Geologist, vol. ii, pl. iii, 1859; and Scottish Carb.
Mon., pl. v, figs. 1—4, 1861.

Spec. Char. Shell large, varying in shape and striation according to age and specimen; somewhat transversely oval; hinge-line straight, exceeding the width of the shell, and sometimes (though not commonly) possessing a narrow rudimentary hinge area in the larger valve. Ventral valve greatly thickened, especially towards the middle, less so at the beak, and near the margin; more or less gibbous, and often much dilated at the ears, which are semi-cylindrically enrolled, and more or less defined. Beak moderately developed, incurved, and overhanging the hinge-line near its extremity only. Exterior evenly convex, or more or less deeply and irregularly furrowed, the surface being covered with a vast number of longitudinal flexuous striæ, which vary according to age and specimen, three or more usually occupying the width of a line towards the middle or margin of the valves. The striæ are also at times confluent, bifurcating, or suddenly disappearing and again re-appearing and increasing in number towards the margin of the valve. They are likewise

contiguous or separated by sulci or interspaces of variable width. At irregular distances the striæ give rise to a few short, cylindrical, hollow spines, which are more numerous upon the auriculate portions of the valve. Dorsal valve thin, concave, following the curves of the opposite one, and similarly sculptured, the visceral portion and ears being also sometimes concentrically wrinkled, while the entire surface is crossed by minute concentric lines of growth. In the interior of the ventral valve the divaricator muscular scars are immediately under and outside of the adductor or oclusor ones, and lower down towards the centre of the valves there are two deep subspiral depressions. In the interior of the dorsal valve the cardinal process is trilobed and V shaped, under which a narrow longitudinal ridge extends to about half the length of the valve, and on either side are situated the ramified dendritic impressions of the adductor or oclusor muscle, while outside and in front of these are the two "reniform impressions." The internal surface is covered with innumerable asperities, and the shell structure perforated by canals. Dimensions variable, four British examples measured—

Length 6 inches 2 lines, width 11 inches 6 lines.

„ 3	„ 9	„ „	6	„ 6	„
„ 4	„ 3	„ „	5	„ 10	„
„ 6	„ 5	„ „	7	„ 8	„

Obs. Of the many species of which the genus *Productus* is composed, this is certainly the largest and most remarkable, some examples having attained eight inches in length by twelve in breadth, but it is also most variable in its shape, so much so, indeed, that one is at times seriously puzzled, and tempted to fabricate more than one so-termed species out of its variations. The shell has been several times minutely described since its first discovery, but Palæontologists are far from unanimous with reference to some of its supposed synonyms. Martin's figure of *Anomites giganteus* represents the adult typical shape of the species, with its developed auriculate expansions, while the same author's *A. crassus* illustrates an adult individual of the same, but in which the ears are broken or undeveloped, and it is quite easy to find in the same quarry and bed specimens graduating from the one into the other. In one, Plate XXXVIII, is represented, of the natural size, a very remarkable example of the typical form, with unusually expanded ears, while in Plate XXXIX (fig. 3) will be found a reduced illustration of a still more circular specimen than that upon which Martin's *P. crassus* was founded. The greater number of Palæontologists have considered *P. hemisphæricus* a synonym of *P. giganteus*, and I am inclined to believe that they are substantially correct, but it must be remembered that in this case the name has been, at any rate, applied to two conditions of the species. James Sowerby's original illustrations in Tab. 328 of the 'Mineral Conchology,' which we consider the typical ones, appear to represent what I take to be a local modification, which had better be described separately with the varietal designation "*hemisphæricus*," while the figures of *P. hemisphæricus* in Tab. 561 of the same work, published some five years later by Mr. J. de C. Sowerby, represent the true adult condition of that shape of *P. giganteus* to which Martin had applied the denomination

"*crassus*." *P. auritus* of Phillips is another undoubted synonym, while *P. Edelburgensis* of the same author represents those examples of *P. giganteus* in which the valves are more coarsely striated, with interspaces of almost equal or greater width, and of which a figure will be found in Pl. XL, fig. 2, of the present work. The striation is, however, sometimes very variable and irregular, even on the surface of a same specimen, and I have at present before me a large example in which the striæ are small, regular, and contiguous for about one inch and a half's distance from the extremity of the beak, then comes a band of about one inch and a quarter in breadth, wherein the ribs become suddenly reduced to nearly half their original number, from many having become obliterated, and thus having left interspaces of irregular width between the remaining striæ; again, for the last two inches, the striæ become suddenly smaller, twice as numerous, irregularly twisted, unequal in their respective widths, and assuming every kind of modification until they reach the margin. In this example, and in many similar ones, we have therefore combined the striation of both the typical *P. giganteus* and its modification *Edelburgensis*. The term, *P. maxima*, was given by M'Coy to that modification of *P. giganteus* in which the valves are uniformly convex and concave, without longitudinal furrows, while the so-termed *P. personatus* was established on what is believed by some to be the internal cast of a circular example of *P. giganteus*, but of which I am not yet perfectly satisfied. We now come to another form, which has by some been considered a synonym, by others a variety, and by many a separate species, viz., *P. latissimus*, Sow., and I confess that it is not easy to satisfactorily determine which of the interpretations comes nearest the truth. It has, however, appeared to me that if *P. latissimus* is not a distinct species, it is certainly a well-marked variety, and had better, at least for the present, be separately described. *Prod. Scoticus*, Sow., and *P. pugilis*, Phillips, have been classed by Professor de Koninck among the synonyms of *P. giganteus*; but this is a mistake, for both those shells, of which I have been able to study the original type, are synonyms of *Prod. semireticulatus*, as will be hereafter shown.

In the young state *P. giganteus* varies almost as much as it does in the adult; it is at times very slightly convex, while the number of striæ are also far less numerous, these last increasing in number as the shell becomes older, by the means of interstriation or bifurcation. A very great disproportion in the respective thickness of the valves is also usually observable, that of the ventral one being in certain examples five or six times greater than that of the dorsal valve. The spines also were far more numerous in certain specimens than in others, and in some specimens a row of short ones projected from close to the cardinal edge of the ventral valve, but never as represented by Von Buch in Pl. I, fig. 1, of his monograph,¹ such a restoration is founded on a supposition which no example I have seen has ever warranted, but they occur sometimes as represented in his fig. 3.

Loc. *Productus giganteus* is common in the English grey lower carboniferous limestone

¹ 'Ueber Productus oder Leptaena Gelesen in der Akademie der Wissenschaften,' 1841.

of Derbyshire; it occurs near Richmond and Thornton Wensleydale, in Yorkshire; while Addleburgh, Bolland, Fountainsfell, Ulverston, Aldstone Moor, Hawes, Askrigg, Dentdale, Rockeley, &c., are given by Professor Phillips as the localities in the carboniferous limestone from whence his specimens were derived. It has also been found in the dark carboniferous limestone of Lowick, Northumberland, as well as in the Isle of Man. In Scotland it characterises some of the lower stages of the carboniferous system, wherein Brachiopoda have been found; thus at Braidwood Gill, in Lanarkshire, it is found for the first time at 397 fathoms below the horizon of the "Ell coal." In Stirlingshire it occurs in the Mill-Burn beds, Campsie. In the island of Arran, and in red limestone at Closeburn, in Dumfriesshire; in Edinburghshire, at Joppa; in Haddingtonshire, at Cat Craig, near Dunbar; in Peebleshire, at Carlops, &c. In Ireland, Mr. Kelly mentions that it occurs in the carboniferous limestone of Cookstown, Millicent, Tankardstown, Tornaroon, Drumreagh Etra, Castle Espie, Armagh, Little Island, &c. On the Continent the species occurs at Visé, Chokier and Temploux being, according to Professor de Koninck, the only localities in Belgium where the shell has been found. It has been also obtained from several Russian localities, such as Karova, Zerovskoi in the Oka of Mydinsk, on the Valdaï, at Peredki, in the basin of the Donetz, &c. In the Oural, at Kamensk and Bielobac in the river Isset, &c. In Silesia it occurs at Altwasser, &c. In Carinthia, in the neighbourhood of Bleiberg and Ratingen, and it has also been discovered at the top of Mount Misery, in Bear Island, along with *P. striatus* and *Punctatus*,¹ &c.

Var.? HEMISPHERICUS. Pl. XL, figs. 4—9.

PRODUCTUS HEMISPHERICUS, *James Sowerby*. Min. Conch., tab. 328, Feb., 1822 (not tab. 561).

— — — *M'Coy*. British Palæozoic Fossils, p. 464, 1855.

Shell hemispherical or transversely oval, hinge-line usually exceeding the width of the shell. Ventral valve evenly convex, ears more or less semicylindrically enrolled, and sloping more or less gradually into the gibbous body. Surface covered with numerous small, rounded, radiating, contiguous striæ, which increase in number by bifurcation as well as by the occasional formation of new striæ between those already existing. The spines are very few on the body of the shell, but a close row of small curved ones line and curve over the cardinal edge. Dorsal valve very concave, following the curves of the opposite one, and similarly ornamented. A few obscure concentric wrinkles may be observed, on the ears of certain specimens. Interior similar to that of *P. giganteus* proper, dimensions variable. Two specimens have measured—

Length 17, width 26 lines.

„ 15, „ 17 „

¹ Further details with reference to the foreign localities wherein this widely spread species has been discovered, will be found in Professor de Koninck's very valuable 'Monographie du genre Productus,' 1847.

Obs. Much difference of opinion has been expressed relative to the shell under description, and it was not until after much examination and hesitation that I determined to provisionally retain the shells first figured by James Sowerby, in tab. 328 of the 'Min. Conch.,' as a variety of *P. giganteus*—a view entertained by Prof. de Koninck, when publishing his monograph in 1847. Prof. M'Coy, describes them as belonging to another and distinct species; so that the subject may still remain an open question, although I am myself inclined to consider *P. hemisphæricus* as nothing more than a local variety of *Productus giganteus*? Mr. E. Wood, who has had occasion to collect *in situ* some hundreds of specimens of this and the typical shape, assures me that the one never occurs in the same bed or zone along with the other; that the bed in which the *P. hemisphæricus* occurs runs for miles along Warfdale in Yorkshire, and that the layer is covered and filled with closely packed specimens of this one fossil, which is also always exactly the same, and much under the true *P. giganteus* bed. My reasons for supposing it a variety of *P. giganteus* are based on the following consideration, viz., that I have several times seen large examples of *P. giganteus* evenly convex, and closely resembling some of the smaller specimens of *P. hemisphæricus* above described,¹ and it is well known that the longitudinal furrows which cover the valves of many examples of Martin's shell are not always present; that the striation of *P. hemisphæricus* agrees likewise with that of many specimens of *P. giganteus*, and that the small curved cardinal spines so constantly present in the Warfdale specimens are also observable in many undoubted large examples of Martin's shell; and, lastly, that the interior is smaller in both. I have also had the advantage of being able to study James Sowerby's original specimens of *P. hemisphæricus*, and found them to agree with those from the gray carboniferous limestone of Warfdale, in Yorkshire.

PRODUCTUS LATISSIMUS, *J. Sowerby*. Plate XXXV, figs. 1—4.

PRODUCTUS LATISSIMUS, *J. Sow.* Min. Conch., pl. 330, Feb., 1822.

— — — *Phillips*. Geol. of Yorks., vol. ii, pl. viii, fig. 1, 1836.

— — — *De Koninck*. Monographie du genre Productus, pl. ii, fig. 2, and pl. iii, fig. 2, 1847.

— — — *Dav.* Scottish Carb. Brach., pl. ii, figs. 8, 9, 1861.

Spec. Char. Shell thin, transversely elliptical or spindle-shaped, with a long, straight hinge-line, the breadth of the shell being more than twice the length. Ventral valve very much vaulted and convex, with a slight mesial longitudinal depression, the gibbosity forming in profile more than a semicircle, while the passage from the body of the valve into the lateral expansions is usually so gradual as to become insensible. The small flexuous striæ which cover the surface augment by the means of numerous interca-

¹ In his work on 'British Palæozoic Fossils,' Professor M'Coy has considered *P. aurita* to be a synonym of *P. hemisphæricus*; and I feel convinced, that any one who examines the Gilbertson specimens of the first (now in the British Museum) will class it among the synonyms of *P. giganteus*.

lations, and from which at intervals project short slender spines. Dorsal valve very concave, following the curves of the opposite valve, and similarly sculptured. In the interior of the ventral valve, the muscular impressions are located in the rostral portion of shell close to the extremity of the beak.

Dimensions variable: a large example measured, length 2 inches, width $4\frac{1}{2}$ inches; a small one, 2 lines by 4.

Obs. At p. 463 of his 'British Palæozoic Fossils,' Prof. M'Coy mentions that "the magnificent suite of specimens of *P. giganteus* now in the University Collection enables him to state positively that the distinctions relied on by M. de Verneuil in the 'Geology of Russia,' and M. de Koninck in his 'Monograph of *Productus*,' for separating *P. latissimus* from *P. giganteus*, do not really exist; several specimens in the collection showing in one individual the gradual conoidal passage of the ear into the body of the shell (as in *P. latissimus*), on the one side, and a narrow sub-cylindrical ear, projecting abruptly from the side of the defined gibbous body of the shell (as in the *P. giganteus*), on the other: that the other characters mentioned as distinctive by them and the older authors, such as thinness of the shell, and few or no longitudinal folds, greater depression of the ears, &c., are characters of the young shell, and particularly the entering valve: further, both forms (contrary to what those authors suppose) occur together in abundance in the same bed in Northumberland." This is not, however, the opinion of the larger number of palæontologists, who cannot recognise in the peculiar spindle shape of *P. latissimus* a simple variation in form of *P. giganteus*; and I must confess that the examinations I have made of many examples of both would not enable me to arrive at so positive an opinion as that of the distinguished author above quoted, although I would not dispute the possibility of its being correct. At all ages and dimensions, from that of four lines in breadth to four inches and a half, the shell appears to retain its very transverse appearance; and its interior dispositions, although similar in character to those of *giganteus*, appear to me somewhat different in their minor details, and, notwithstanding what has been asserted by M'Coy, the shell seems to me much thinner than that of Martin's species.

In England, *P. latissimus* is common in the limestone and shales of various localities. Sowerby mentions that it occurs in a cherty limestone at Tyddmaur Farm, in Anglesea; it is not uncommon at Settle in Yorkshire, Fountains Fell, Kirby Lonsdale, in Northumberland, &c. In Scotland, it is one of the most characteristic species in some of the lower stages of the Carboniferous system: it is found in Lanarkshire at two different levels; thus at Belston Burn it occurs at 265 fathoms below "Ell Coal," and 391 at Braidwood Gill, also at Brockley, near Lesmahago; in Renfrewshire, at Arden Quarry, Thornliebank; in Ayrshire, at Roughwood and West Broadstone Beith, &c.; in Stirlingshire, in the Craigenglen (Campsie) beds. In Ireland, it is stated by Mr. Kelly to occur in the calciferous slate and carboniferous limestone of Lisnapaste, Killymeal, and Raheendoran. On the Continent, it has been found at Visé in Belgium, and in several Russian localities.

PRODUCTUS HUMEROSUS, *Sow.* Pl. XXXVI, figs. 1, 2.

PRODUCTUS HUMEROSUS, *Sow.* Min. Conch., t. 322, January, 1822.

- HORRIDUS, *De Koninck.* Mon. du genre Productus, 1847 (not of Sow. ?)
- ACULEATUS (*Schlotheim*), *Von Buch.* Über Productus oder Leptaena Akademie der Wissenschaften, p. 35, 1841.

Of this *Productus* internal casts alone have been hitherto found, so that no description of the exterior can be given. The length generally slightly exceeds the breadth, while the hinge-line is usually somewhat shorter than the width of the shell. The ventral valve was gibbous and of great thickness, with perhaps a slight longitudinal depression or sinus? while the dorsal one was concave, light, and thin. The interior details are sharply sculptured upon the internal casts. The ventral valve in the cast is very remarkable on account of two large projecting conical protuberances situated about the middle of the shell, with their extremities directed towards the beak, and which in the enormously thickened shell formed very deep cavities, which no doubt afforded accommodation to the spirally coiled? oral arms. The muscular impressions form also in the cast a remarkable protuberance, and in the shell itself occupy the rostral or incurved portion under the cavity of the beak. The adductor or occlusor produces two radiating dendritic impressions, longitudinally divided by a narrow ridge, and on either side there is (in the shell) a deep, strongly grooved or striated sub-quadrate impression, which is due to the cardinal or divaricator muscle, the remainder of the inner surface of the valve being covered with rugosities. In the interior of the dorsal valve, the quadruple impressions of the adductor, as well as the reniform impression, do not differ from those of the generality of *Producta*. The absence of the shell itself renders specific determination uncertain, and the name is consequently only provisionally retained. In their monographs, Baron von Buch and Prof. L. de Koninck have placed *P. humerosus* among the synonyms of the Permian *P. horridus*; and although I would not deny the possibility of this view being correct, still as none of the internal casts of the Permian shell, that have come under my observation, have exhibited those enormously developed and peculiar conical protuberances present in the Carboniferous casts, and as the muscular impressions in the ventral valve differ also somewhat in their details, I have preferred (at least provisionally) retaining the denomination under which the Carboniferous *Productus* is generally known.

The internal casts of *P. humerosus* are from the Magnesian Limestone of the Carboniferous series of Breedon in Leicestershire, and a fine series of specimens may be seen in the Collection of the Geological Society and British Museum.

PRODUCTUS CORA, *D'Orbigny*. Pl. XXXVI, fig. 4, and Pl. XLII, fig. 9.

PRODUCTUS CORA, *D'Orb.* Paléontologie du Voyage dans l'Amérique Méridionale, pl. v, fig. 8, 9, and 10, 1842.

— *COMOIDES*, *De Koninck*. Descrip. des Anim. Fossiles du Terrain Carb. de la Belgique, pl. xi, fig. 2^{a, b}, and fig. 5^{a, b}, (not of Sow.), 1843.

— *CORRUGATA*, *M'Coy*. Synopsis of the Carb. Limest. Fossils of Ireland, pl. xxvi, fig. 13, 1844.

— *NEFFEDIEVI*, *De Verneuil*. Russia and the Oural Mountains, vol. ii, pl. xviii, fig. 11, 1845.

— *CORA*. *De Koninck*. Monographie du genre *Productus*, pl. iv, fig. 4, and pl. v, fig. 2, 1847.

— *CORRUGATA*, *M'Coy*. British Pal. Foss., p. 459, 1855.

— *PILEIFORMIS*, *M'Chesney*. Desc. of New Species of Fossils from the Palæozoic Rocks of the Western States of America, p. 40, 1859.

— *CORA*, *Dav.* Mon. of Scottish Carb. Brach., pl. iv, fig. 13, 1860.

Spec. Char. Shell thin, longitudinally oval, or semi-cylindrical, usually longer than wide; hinge-line about as long as the breadth of the shell; ventral valve gibbous, evenly convex, or slightly flattened along the middle: beak wide and incurved; ears small, and generally crossed by four or five deep undulating folds or large wrinkles, which extend to some distance over the lateral portions of the valves. Surface covered with numerous longitudinal, straight or slightly flexuous, narrow, thread-like, rounded striæ, with sulci or interspaces of rather less width, while smaller striæ are often intercalated between the larger ones, the ribs being also regularly crossed by small concentric lines. Spines few in number, sparingly scattered over the surface, but more numerous on the ears. Dorsal valve concave, following the curves of the opposite one, and similarly ornamented.

Dimensions variable, some examples have attained or exceeded two and a half inches in length, by three and a half in width.

Obs. This *Productus* is well characterised and distinguishable from its congeners both by shape and sculpture; but the four or five large concentric wrinkles which usually cover the ears and lateral portions of the valves are much less developed in certain examples than in others. In the dorsal valve, the visceral portion of some specimens is also entirely crossed by a variable number of concentric folds or wrinkles (as represented in Pl. XLII, fig. 9), but which do not exist in the generality of specimens. The shell varies likewise very much in shape, being at times almost oval, while in other examples the margin becomes considerably expanded. Prof. de Koninck, who has had the advantage of being able to examine D'Orbigny's original specimens, positively asserts that they cannot be distinguished from the European examples we are now describing, and that consequently Prof. M'Coy's *P. corrugata* will require to be added to the synonyms; and I believe that my Belgian friend is likewise correct when he refers the Russian *P. Neffedievi* to D'Orbigny's species.

In England, *P. cora* has been found in the carboniferous limestone of Kendal, Lowick, Settle, Poolwash (Isle of Man). In Scotland, in the Mill Burn and Balgrochan beds, as well as Campsie Main limestone, Stirlingshire; at Arden Quarry, near Thornliebank, in Renfrewshire; West Broadstone, near Beith, Ayrshire. In Ireland, at Larganmore, Millicent, Milverton, Skerries, Little Island, &c. In Belgium, at Visé, Tournay, &c. In Russia, at Cosatchi-Datchi, near Sterlitamak, &c. In America, it was found by D'Orbigny in a blue compact limestone above Patapatani, in one of the islands of the lake Titicaca, and in a gray limestone at Yarbichambi. It has been also obtained from the Mountain Limestone of Chester, Illinois, and by Dr. Fleming and Mr. Purdon in the Punjab (India), &c. &c.

PRODUCTUS SEMIRETICULATUS. Pl. XLIII, figs. 1—11, and Pl. XLIV, figs. 1—4.

- ANOMITES SEMIRETICULATUS, *Martin*. Petrif. Derb., pl. xxxii, figs. 1, 2, and pl. xxxiii, fig. 4, 1809.
- PRODUCTUS, *Martin*. Ib., pl. xxii, figs. 1—3.
 - SCOTICUS, *Sow.* Min. Con., pl. lxix, fig. 3, Oct., 1814.
 - MARTINI, *Sow.* Ib., pl. 317, figs. 2—4, Dec., 1821.
 - ANTIQUATUS, *Sow.* Ib., figs. 1, 5, and 6.
 - CONCINNUS, *Sow.* Ib., pl. 318, fig. 1, 1821.
 - MARTINI and ANTIQUATUS, *Phil.* Geol. York., pl. vii, fig. 2, 1836.
 - PUGILIS, *Phil.* Ib., pl. viii, fig. 6.
- LEPTENA ANTIQUATA, *Fischer*. Oryct. du Gouv. de Moscou, pl. xxvi, figs. 4, 5, 1837.
- TUBULIFERA, *Fischer*. Ib., pl. xxvi, fig. 1 (not Deshayes).
- PRODUCTUS MARTINI, *De Kon.* Desc. des Animaux Foss. du Terrain Carb. de la Belg., pl. vii, fig. 2, 1843.
- INCA, *D'Orb.* Paléont. du Voyage dans l'Amérique Mér., pl. iv, figs. 1—3, 1844 (according to M. de Koninck).
 - PERUVIANUS, *D'Orb.* Ib., fig. 4.
 - FLEXISTRIA, *M'Coy*. Synopsis of the Carb. Limest. Fossils of Ireland, pl. xvii, fig. 1, 1844?
 - SEMIRETICULATUS, *De Kon.* Mon. du genre Productus, pl. viii, fig. 1; pl. ix, fig. 1; pl. x, fig. 1, 1847.
 - — and MARTINI, *M'Coy*. Brit. Palæozoic Fossils, pp. 467 and 471, 1855.
 - — *Dav.* Mon. of the Scottish Carb. Brach., pl. iv, figs. 1—5, 7, and 12, 1860.
 - — *Salter*. Quarterly Journal of the Geol. Soc., pl. vi, fig. 1, 1861.

Spec. Char. Very variable in shape, transversely oval, sub-cylindrical or elongated; hinge-line as long or somewhat shorter than the width of the shell; ventral valve gibbous and variably vaulted, with a shallow longitudinal median sinus or depression; auriculate expansions moderately developed; beak wide, incurved, usually covered with irregular, con-

centric, undulating wrinkles, larger and deeper upon the ears, while the entire surface of the shell is ornamented by many radiating, longitudinal, rounded striæ, which become more numerous towards the margin from bifurcation and interstriation, and from which project, at variable intervals, tubular spines of sometimes considerable length. Dorsal valve moderately concave, following the curves of the opposite one, and similarly sculptured. Dimensions variable, some examples having attained three inches in length, by four in breadth.

Obs. This species has varied very much in its general shape, and I am disposed to coincide with Prof. de Koninck, while considering *P. semireticulatus*, *P. antiquatus*, *P. Martini*, *P. concinnus*, and, I will add, *P. Scoticus*, as simple variations in shape of a single species, and for which the term *semireticulatus* is here retained. I am also quite ready to admit that, if we examine only typical examples of *P. semireticulatus* and *P. Martini*, a certain degree of difference is perceptible, on account of the profile of the first being simply semicircularly curved, while in the second the valves are geniculated; but these two extreme shapes are intimately connected by insensible gradation, and indeed very often to such an extent that it would be impossible to say to which in particular certain specimens should be referred. In Mr. Salter's opinion, *P. costatus* should also be considered a variety of the species under description;¹ and although that learned palæontologist may be quite correct in his supposition, I do not feel myself at present sufficiently justified in uniting the two under a single denomination. *P. sulcatus* has, I fear, without sufficient caution been located, by myself and others, among the synonyms of *P. semireticulatus*, but I am now inclined to consider it a variety of *P. costatus*, for reasons which will be given hereafter. *P. Scoticus*, of which I have seen the original type, appears undistinguishable from *P. semireticulatus*; and several other so-termed species must likewise be placed under the same denomination.

The width of the striæ, as well as the interspaces between them, vary also according to the specimen, two or more usually occupying the breadth of a line. The larger number are simple, but others bifurcate here and there, and especially so on the lateral portions of the shell; two or more in rarer cases will also sometimes unite towards the margin so as to form a single rib, while others are due to intercalation. Several ribs at times cluster together so as to produce an elevation, and thus give to the frontal portion of the shell a somewhat grooved or undulated appearance; and this was particularly the case with the crushed specimen from which Phillips founded his *P. pugilis*, the original example being still preserved in the author's collection. In the species under description, the spines are likewise often more numerous and longer in certain specimens than in others, but always most so upon the auriculate portions of the valve, where they do not appear to have been generally disposed in a double row, or rather to have protruded from an elevated ridge, as in *P. costatus*, and its variety, *P. sulcatus*.

¹ 'Quarterly Journal of the Geol. Soc.,' vol. xvi, p. 441.

The interior need hardly be described, as the details which we have carefully drawn do not differ materially from those already noticed in other Producta ; so that all we require to notice is that, in the ventral valve, the adductor or oclusor muscular impressions are situated almost on a level, or are longitudinally parallel, with the divaricator scars, and consequently much lower in the ventral valve than in *P. giganteus* and some other species. In the dorsal valve, the oclusor impressions are often beautifully sculptured, and the cardinal process tri-lobed. The ventral valve is more thickened than the dorsal one, and possesses sometimes, though rarely, a well-defined area and fissure covered by a pseudo-deltidium, this character being beautifully displayed upon a specimen in the British Museum, and of which an illustration will be found in my plate. Since several palæontologists appear, however, desirous of maintaining the term *Martini* as at least a varietal designation, and although I cannot draw any line of distinction between the two, it may be as well to mention that figs. 6 to 11 of my Pl. XLIII represent the typical shapes of *P. Martini*, while the other figures would represent *P. semireticulatus*. In its typical condition, *P. Martini* may be distinguished by the great length and sometimes irregularity of its anterior prolongation, the visceral portion alone being regularly arched, the shell becoming afterwards suddenly bent downwards in an almost straight line, giving to some specimens a peculiarly elongated and geniculated appearance, as seen in figs. 6 and 7. The sudden bend of the ventral valve makes it sometimes, in the fossil state, liable to fracture where the sudden bend in the valve takes place, as seen in figs. 9 and 10. The lateral portions of the valve are likewise much dilated, while numerous spines, clustered together, project from the auriculate portions of the valve. This is also the variety to which Martin, in 1809, applied the specific denomination of *Anomites productus* ; and Sowerby's *P. concinnus* is evidently nothing more than a smaller form or synonym of the same. *Productus semireticulatus* is one of the most abundant and far-spread species of the genus, and is found in almost every locality where Carboniferous Brachiopoda occur.

In England it is found in the Carboniferous Limestone and shales of Bolland, Settle, Kirkby Lonsdale, Coverdale, as well as in various Derbyshire localities ; at Poolwash, in the Isle of Man ; Clifton, near Bristol, &c. In Scotland, it is plentiful in Lanarkshire, Renfrewshire, Ayrshire, Dumbartonshire, Stirlingshire, Fifeshire, Edinburghshire, Dumfries-shire, Peeblesshire, Linlithgowshire, and Berwickshire. In Ireland, at Millecent, Lisnapaste, Tankardstown, Tornaroan, Cookstown, &c. In Belgium, it occurs in the lower stages of the Carboniferous Limestone of Visé, De Chokier and De Lives, near Namur, and in various other localities, as well as in the Middle Limestone of Tournay. M. de Koninck states he has found it likewise in the following German localities :—Crumford, at Ratingen, Altwasser, &c. In Russia, M. de Verneuil and Count Keyserling obtained it in several localities such as the neighbourhood of Moscou, on the Dwina, the Oka, the Pinega, and Petschora, as well as in the Timans Mountains, near the Glacial Sea, also in the Oural Mountains, at Sterlitamak, &c. M. de Tchihatchef found it also in the Altai Mountains. It has also been found in Spitzbergen and Australia ; in the Punjaub, and in various

American localities, such as at the Island of Quehaja, near the Lake Titicaca, at the foot of the Bolivian Andes; at Quincy, Illinois; Keokuk, Iowa, &c.

PRODUCTUS COSTATUS, *J. de C. Sow.* Pl. XXXII, figs. 2—9.

PRODUCTA COSTATA, *J. de C. Sow.* Min. Conch., pl. 560, fig. 1, May, 1827.

— *SULCATUS*, *Sow.* Ib., pl. 319, Jan., 1822.

— *COSTATA* (et *SULCATA*, *Sow.*), *Phillips.* Geol. of York., vol. ii, pl. vii, fig. 2, 1836.

— *COSTELLATUS*, *M'Coy.* Synopsis, pl. xx, fig. 15, 1844.

— *COSTATUS*, *De Verneuil.* Russia and the Ural Mountains, vol. ii, pl. xv, fig. 13^{a, b}, 1845.

— — *De Koninck.* Mon. du genre *Productus*, pl. viii, fig. 3, and pl. x, fig. 3, 1847.

— — *Dav.* Mon. of Scottish Carb. Brach., pl. ii, figs. 22—24, 1860.

Spec. Char. Shell very variable in shape, transversely semi-cylindrical, wider than long; hinge-line about as long as the width of the shell. Ventral valve gibbous, very much vaulted; abruptly arched, or obscurely geniculated; beak incurved, but not overlying the hinge-line except at its attenuated extremity, a median longitudinal sinus or depression dividing the valve to a greater or less extent into two lobes; ears more or less developed, sloping abruptly from the visceral portion, with a strong, rugged, semicircular ridge on either side, obliquely placed to the hinge-line, and from which project several long, cylindrical, hollow spines, similar to those situated close to the cardinal edge. Surface covered with a variable number of strong, longitudinal rounded ribs of unequal width, and which become more numerous towards the margin from occasional bifurcation or intercalation, while the whole visceral portion is crossed by numerous regular concentric wrinkles, producing reticulate tuberculations. The spines are long, but variable in number, projecting here and there from the ribs. Dorsal valve somewhat geniculated, following the curves of the opposite valve, a slight median elevation corresponding to the sinus of the ventral valve; the visceral portion is usually somewhat flattened, while the anterior portion of the valve becomes more or less abruptly bent upwards, the sculpture being similar to that of the opposite valve.

Dimensions variable: a typical specimen measured, length 18, width 23 lines.

Obs. So variable do the shells composing this species appear to be, that it is very puzzling to know how to dispose of certain shapes which, although individually somewhat different from the typical form, appear, nevertheless, linked to them by insensible gradation. Sowerby states his species to be "transversely oblong, with an angular depression in the middle; costæ few, broad, decussated at their upper part, compressed upon the deflected front, each side furnished with two or three spines and a small tube." This description will suit typical specimens, such as the one the author had at the time

before him, but it would scarcely be equally applicable to all the shells which compose the species. Thus, the median depression is extremely shallow, and even absent in certain examples; the characteristic rugged, semicircular ridge, with its strong, elongated spines, present on typical specimens, is at times very little developed, and even absolutely wanting in certain examples, while the number of ribs will vary from eighteen to fifty, and are more often rounded than flattened, the spines being likewise more numerous on some examples than on others. When publishing my monograph of Scottish Carboniferous Brachiopoda I erroneously placed Sowerby's *P. sulcatus* among the synonyms of *P. semireticulatus*, but a more attentive examination of the subject has convinced me that Phillips was correct when, in 1836, he placed *P. sulcatus* among the synonyms of the species under description.¹ M'Coy's *P. costellatus* is evidently a synonym of *P. costatus*, but it is more difficult to determine whether *P. muricatus* and another closely allied form from Corrieburn, in Stirlingshire, should be considered as varieties of Sowerby's *P. costatus*. Having obtained the loan of the original example of *P. muricatus* preserved in the museum at York (fig. 11 of my plate), I found that it was imperfect, and much more circular than the typical and usual shapes of *P. costatus*; but it presented, however, the same median depression, and although the tubular spines projecting from the convex surface of the ribs were more numerous, still intermediate forms seemed to unite Phillips's species to *P. costatus* proper. I am therefore inclined to believe that *P. muricatus* is only a variety of the shell under description, or a race peculiar to certain localities; but as I may be mistaken, and in order to allow the subject to remain an open question, I will describe Phillips's shell under a separate or varietal denomination.

Var.? *P. MURICATUS*, *Phillips*. Pl. XXXII, figs. 10—14.

PRODUCTA MURICATA, *Phillips*. Geol. of York., pl. viii, fig. 3.

Shell circular, about as long as wide; hinge-line somewhat shorter than the greatest width of the shell; ventral valve regularly arched, so as to present in profile nearly a half circle, uniformly convex, or slightly longitudinally depressed along the middle; beak large, wide, rounded and incurved, but not overlaying the hinge-line except at its attenuated extremity; ears very small; surface covered with numerous rounded ribs, of unequal width, augmenting in number here and there by bifurcation or intercalation, while two or three will sometimes unite into one; long, slender spines project at intervals from the ribs, and form also a row close to the cardinal edge. Dorsal valve regularly concave and similarly sculptured. Proportions variable. Two specimens have measured—

Length 11, width 10, greatest depth 5 lines.

„ 10½ „ 11 „ „ 5 „

¹ As already mentioned under *P. semireticulatus*, Mr. Salter is inclined to consider the last-named shell and *P. costatus* as varieties of a single species.

To the typical forms of this variety we have united certain specimens from Corrieburn, of which the figs. 13 and 14 of our plate are representations; but it is desirable, at the same time, to mention that the Corrieburn specimens are remarkable on account of the narrowness or smallness of their ribs, none much exceeding half the width of those of Phillips's type; and as the general form of the shell in both, as well as the arrangement of the spines, is similar, I have not ventured to apply to it a separate specific denomination, although it may possibly be distinct. One of the principal differences observable in *P. muricatus* lies in the ventral valve being regularly convex, and the dorsal one regularly concave, while in all well-shaped examples of *P. costatus* the valves are generally somewhat obscurely geniculated. The interior of *P. muricatus* is still unknown, but the dorsal valve of *P. costatus* has been found several times, and does not differ in its details from what we observe in other *Producta*.

P. costatus has been obtained from the Carboniferous limestone of several English localities, such as Settle and Richmond, in Yorkshire; at Bolland; in the dark Carboniferous limestone of Lowick, Northumberland, &c. In Scotland it has been found at Hillhead, and Brockley, in Lanarkshire; Barrhead, in Renfrewshire; Roughwood and West Broadstone, &c. In Ireland, in the upper limestone of Old Leighlin.

Prof. de Koninck states in his 'Monographie' that he has not discovered the species in Belgium, but I possess a specimen from Visé identical in shape and character with many of our British forms. In Russia it occurs in the Carboniferous limestone of the neighbourhood of Sloboda, Government of Toulá, also of Botcharova, on the Volga, &c. In the limestone of St. Louis, in the Missouri, America, very abundant and unusually large; in the Punjab, &c.

The variety *P. muricatus* is stated by Phillips to occur at Harelaw and Kirby Lonsdale. In Scotland it has been found at Cessnock, and Gateside Beith, in Ayrshire, at Corrie-burn, in Stirlingshire, and Castlecary, in Dumbartonshire.

PRODUCTUS LONGISPINUS, Sowerby. Pl. XXXV, figs. 5—17.

ANOMIÆ ECHINATÆ (pars), *Ure*. History of Rutherglen, p. 314, pl. xv, figs. 3, 4, 1793.

PRODUCTUS LONGISPINUS, *Sow*. Min. Conch., vol. i, p. 154, pl. lxviii, fig. 1, October, 1814.

— FLEMINGII, *Sow*. Ib., fig. 2.

— SPINOSUS, *Sow*. Ib., pl. lxix, fig. 2, 1814.

— LOBATUS, *Sow*. Ib., pl. 318, figs. 2—6, 1821.

— ELEGANS, *Davreux*. Const. Géol. de la Prov. de Liege, p. 272, 1833 (according to De Koninck).

— SETOSA, *Phillips*. Geol. of Yorkshire, vol. ii, pl. viii, figs. 9 and 17, 1836.

— LOBATUS, *V. Buch*. Verhandl. der Königl. Akad. der Wissens. zu Berlin, aus dem jahre, Theil. i, p. 32, pl. ii, fig. 17, 1841.

— CAPACII, *D'Orb*. Paléont. du Voyage dans l'Amérique Méridionale, pl. iii, figs. 24—26, 1843.

- PRODUCTUS LONGISPINUS, *De Koninck*. *Descript. des Animaux foss. du terr. Carb. de Belgique*, p. 187, pl. xii, fig. 11^{a, b}, and pl. xii^{bis}, fig. 2, 1843. *P. Flemingii*, *Mon. du genre Productus*, pl. x, fig. 2, 1847.
- LOBATUS, *De Verneuil*. *Russia and the Ural Mountains*, vol. ii, pl. xvi, fig. 3; pl. xviii, fig. 8, 1845.
- TUBARIUS, *De Keyserling*. *Reise in das Petschora Land*, p. 208, pl. iv, fig. 6, 1846.
- LONGISPINUS, *Dav.* *Introduction to British Fossil Brach.*, pl. ix, fig. 221, 1853.
- WABASHENSIS, *Norwood and Pratten*. *Notice of Producti in the Western States and Territories*, *Journal of the Academy of Nat. Sciences of Philadelphia*, pl. i, fig. 6, 1854.
- SPLENDENS, *Norwood and Pratten*. *Ib.*, pl. i, fig. 5.
- FLEMINGII, *M'Coy*. *British Palæozoic Fossils*, p. 461, 1855.
- LONGISPINUS, *Dav.* *Mon. Scottish Carb. Brach.*, pl. ii, figs. 10—19, 1860.

Spec. Char. Shell very variable in shape, rather small, subcylindrical, usually slightly transverse, rarely longer than wide: hinge-line as long, or a little shorter than the greatest width of the shell; frontal margin rounded or more or less indented. Ventral valve gibbous, evenly convex, or more or less divided into two lobes by a longitudinal sinus of variable depth, commencing at a short distance from the extremity of the beak; auriculate expansions small; beak incurved, but rarely protruding much beyond the hinge-line. Dorsal valve moderately and uniformly concave, following the curves of the opposite valve, or with a small mesial fold slightly developed towards the front. Surface of each valve covered with numerous small, longitudinal, rounded striæ, tolerably regular in their course and respective widths, but augmenting in number by occasional bifurcation and intercalation. Visceral portions crossed by small, concentric, undulating wrinkles, more developed upon the auriculate expansions; long tubular spines project from some of the ribs at irregular intervals, more numerous on the ears. Dimensions variable; two British examples measured—

Length 9, width 10 lines.

„ 8, „ 7 „

Obs. At least nine or ten so-termed species have been fabricated out of variations in shape of this common, far-spread, very variable species; but as the study of the types themselves and of a multitude of specimens has clearly shown that every variety or variation is intimately connected by intermediate gradation and inseparable links, we should not be justified in retaining, even as varietal denominations, any of the names enumerated among the synonyms. In Great Britain the shell does not appear to have ever attained much larger proportions than those given above; and as the term *longispinus* is the best known and first recorded in the 'Mineral Conchology,' it is retained from the species. *P. Flemingii* was badly drawn from a very imperfect specimen, nor does Sowerby's figure even do justice to the original specimen, which, along with *P. longispinus* and *spinosus*, may

still be seen in Dr. Fleming's collection. *P. spinosus* is another condition or variation of the shell under description, while *P. lobatus* represents those specimens in which the median sulcus is very much developed, while every connecting link can be found in the same bed and quarry between the evenly convex specimens and those with a deepened median sinus. The striation is sometimes very fine in some examples, coarse in others, so that on two shells of the same dimensions fifty ribs will be counted on the ventral valve of the one, thirty on the other; the hinge-line is also in many examples shorter than the width of the shell, longer in others. The long, slender, tubular spines which are scattered over its surfaces vary likewise considerably in number in different individuals, and Sowerby was almost correct while mentioning that "two principal ones are nearly straight and cylindrical, attached to the convex side of the convex valve, and extending in line parallel to the hinge." These two spines are rather constant in the majority of specimens I have examined, and are often seen as represented in Sowerby's figure (5 of my plate), but not always parallel to the hinge; the other spines are more irregularly scattered over the surface, while some are two or even three times as long as the length of the entire valve. Many of the most marked modifications in shape assumed by this species have been carefully represented in my plate, and these will suffice to show how large a range of variation must necessarily be given so as not to violate the laws of nature. Beautifully perfect interiors of both valves are not rare in certain localities. On the concave surface of the ventral one two elongated contiguous dendritic adductor or oclusor impressions project at times considerably above the level of the valve, and immediately under, but outside, of these may be seen the two large longitudinally striated subquadrate impressions, attributable to the divaricator muscle, while a glance at my figures of this and the corresponding valve of *P. semireticulatus* will show the difference in position occupied by these muscles in the two species. The oclusors in the last-named shell are almost upon a level and longitudinally parallel with the divaricator, while in *P. longispinus* the divaricators commence only at or close to the base of the oclusors. A difference in the arrangement of these muscles occurs likewise in *P. punctatus*, and denotes that the three species might be distinguished alone by the details connected with their interior arrangements. In the interior of the dorsal valve the cardinal process is proportionally large and trilobed, under which a median longitudinal ridge extends to a little more than half the length of the valve, and becomes much elevated and thickened towards its extremity; on either side may be seen a pair of dendritic scars formed by the adductor or oclusor muscle; the reniform impressions are also well defined and often much raised, and the surface of the valve is covered near its margin with numerous spinulose asperities; minute canals traversing the valves are also clearly visible in the shape of punctures, especially upon specimens that have been slightly weathered.

In the 'Geology of Yorkshire,' Prof. Phillips figures two variations in shape of the shell under description by the name of *setosa*; his fig. 9 (15 of my plate) is a large, but not unusual, shape of *P. longispinus*, while his fig. 17 (16 of my plate) is a rarer condition of

the same shell, but of which many examples have been found in the same quarries along with every intermediate passage form. Possessing examples of Norwood and Pratten's *P. Wabashensis* and *P. splendens*, I could not recognise the smallest difference between them and the generality of our Scotch examples of Sowerby's shell, and I have but little doubt that the list of synonyms might be further increased had we the means of comparing certain so-termed species with our British forms. I consider that Prof. M'Coy is, however, mistaken while locating *P. pugilis*, Phillips, and his own *P. costellatus* among the synonyms of the shell under description. In England *P. longispinus* is common in the Carboniferous limestone and shales of several Derbyshire and Yorkshire localities, and at Lowick, Northumberland, Poolwash, Isle of Man, &c.

In Scotland it is exceedingly abundant in various counties, and occurs in several stages. At Braidwood, in Lanarkshire, it occurs at 337 fathoms lower than the "Ell Coal," and a little lower again at Halleraig, Raes Gill, Langshaw, Hillhead, Kilcadzow, &c., in the Parish of Carluke; also in the same county at Kersgill and Brockley, near Lesmahago, Auchentibber, and Calderside, High Blantyre, Capel Rig, East Kilbride,¹ &c. It occurs also in Renfrewshire, Dumbartonshire, Ayrshire, Stirlingshire, Edinburghshire, Haddingtonshire, Fifeshire, &c.

In Ireland it occurs in the Calciferous slate and Carboniferous limestone of many localities, such as Lisnapaste, Howth, Ballyduff, Mohill, Hook, Bundoran, Millicent, Culkagh, &c.

In Belgium, at Visé, Tournay, &c., and, indeed, is found in almost any Carboniferous district where Brachiopoda have been found. In Russia, at Karova, Government of Kalouga, &c. Yarbichambi, on the edge of the Lake Titicaca, on the Bolivian table-land of the Andes, and Sangamon, County Illinois, in America, &c. In the Carboniferous limestone of the Punjab in India. Carrocreek in Tasmania, &c.

PRODUCTUS SINUATUS, *De Koninck*. Pl. XXXIII, figs. 8—11.

LEPTÆNA SINUATA, *De Koninck*. Description des Animaux fossiles du Terrain Carb. de la Belgique. Supplément, p. 654, pl. lvi, fig. 2, 1851.

— — *M'Coy*. British Palæozoic Fossils, p. 453, 1855.

PRODUCTUS SINUATUS, *Dav.* The Geologist, vol. iv, p. 48, Feb., 1861.

Spec. Char. Shell transverse, longer than wide; obscurely subtetragonal; hinge-line about as long as the greatest width of the shell; cardinal angles rounded. Ventral valve geniculated from the anterior half, being bent at right angles to the posterior or visceral portion; ears large, reflexed, curving away from the hinge-line; visceral disc somewhat flattened, but divided by a longitudinal sinus commencing at a short distance

¹ In his 'History of Rutherglen and East Kilbride,' published in 1793, David Ure gives two figures of the shell under description.

from the small, slightly convex beak, and extending to the front, dividing the valve into two convex lobes. Cardinal area well defined, subparallel and narrow, divided by a small fissure covered by a pseudo deltidium. Surface ornamented by numerous small, rounded, longitudinal striæ, sometimes bifurcating or increasing in number by intercalation at various distances from the beak, and crossed by numerous small, concentric lines or wrinkles, while about fourteen long, vertical, slender, tubular spines are arranged in two rows close to the cardinal edge. The dorsal valve follows the curves of the opposite one, but has a mesial elevation in lieu of a sinus, and is similarly sculptured. Dimensions variable; length 7 inches, width 12 lines.

Obs. Of this remarkable species a few imperfect examples were discovered for the first time by Prof. de Koninck in the Carboniferous limestone of Visé, in Belgium, and who, misled by the well-defined ventral area, supposed his species to be referable to the genus *Leptaena*. Prof. de Koninck's figures do not represent the perfect condition of the shell, for none of his examples retained the peculiarly extended and reflexed ears which I have drawn with great care from some very perfect specimens discovered by Mr. Burrow in the Lower Scar limestone of Settle, in Yorkshire, and from which my description is taken. When it so happens that, from fracture, the auriculate expansions are absent and that the area is not exposed, some examples in this condition might be mistaken for certain deeply sinuated specimens of *P. longispinus*, but the last-named shell is usually more regularly vaulted and rarely geniculated to the extent observable in *P. sinuatus*. Interiorly, both species differ in the position which the adductor muscular impressions in the ventral valve occupy relative to the divaricator ones; those in *P. sinuatus* being longitudinally parallel or on a level with the divaricators, while in *P. longispinus* the last-named, muscular scars commence under and outside of the adductor impressions, so that in Sowerby's shell the four muscular scars in the ventral valve occupy a larger space than in *P. sinuatus*, where they are all on a level or parallel to each other, and occupy a small saucer-shaped space in the rostral portion of the valve. In the dorsal valve the muscular and reniform impressions do not appear to differ much in detail from those of *P. longispinus* or of the generality of other *Producta*, and in any case the interior markings denote with certainty that *P. sinuatus* is a true *Productus*, and could in no case be classed with *Leptaena*. None of the specimens or internal casts exhibited evidence of teeth, so that it is probable that the valves were unarticulated, as they appear to be in all known species of the genus.

Prof. M'Coy mentions that the shell under description is rare in the Carboniferous limestone of Derbyshire, and it has been recently discovered at Bowertrapping, near Dalry, Ayrshire, Scotland, and which I was happy to recognise among some duplicates forwarded to me by Mr. Young.

PRODUCTUS MARGARITACEUS, *Phillips*. Pl. XLIV, figs. 5—8.

PRODUCTA MARGARITACEA, *Phillips*. Geol. of Yorksh., vol. ii, p. 215, pl. viii, fig. 8, 1836.

— PECTINOÏDES, *Phillips*. Ib., pl. vii, fig. 11.

— MARGARITACEUS, *De Kon.* Desc. des Anim. foss. du Terr. Carb. de Belgique, pl. vii, fig. 3; pl. viii^{bis}, fig. 5, 1843. Mon. du genre Productus, pl. iv, fig. 3, 1847.

— — *De Keyserling*. Wissensch. Beobacht. auf einer Reise in das Petschora Land., p. 210, pl. iv, fig. 7, 1846.

— — *M'Coy*. British Palæozoic Fossils, p. 466, 1855.

Spec. Char. Shell thin, somewhat circular or transversely semicircular, rarely longer than wide; hinge-line rather less than the width of the shell. Ventral valve regularly convex, without sinus; beak small, incurved; ears narrow and but slightly distinguishable from the general convexity of the valve; surface ornamented with numerous thick, obtusely rounded or flattened ribs, separated by shallow sulci, the costæ often bifurcating near the margin, while the whole surface is closely crossed by concentric imbricating striæ, which at intervals produce strongly marked foliaceous interruptions or lines of growth. The spines are few in number, but four or five strong ones project from each of the auriculate expansions, while two or three more are sometimes irregularly scattered over the surface. Dorsal valve concave, following the curves of the ventral one, and similarly ornamented. Interior details imperfectly known. Dimensions variable; two British examples have measured—

Length 15, width 18 lines.

„ 17, „ 16 „

Obs. This is a well-marked species, easily distinguishable from its congeners, both by shape and sculpture. Its shell is likewise remarkably thin and delicate, the ears very brittle and often broken, while the space occupied by the animal between the valves is very small. In shape it is more often transverse, and to this variety the name *margaritacea* had been applied, while to the rarer or elongated form that of *pectinoides* was given; but as every gradation in shape between the two can be readily found, a single specific denomination can alone be retained.

P. margaritaceus does not appear to be a very common species, and is confined to the middle and lower stages of the Carboniferous system. In England it occurs at Bolland, Kendal, Settle, in Yorkshire, as well as in some Derbyshire localities, &c. In Ireland it may be obtained at Florence-court, Millecent, Kildare. Mr. Kelly mentions also Lisnapaste, Bundoran, and one or two more places where it is said to occur.

On the Continent it is not abundant in the Carboniferous limestone of Visé and Tournay in Belgium, and has been found at Ratingen, D'Altwasser, in Silesia, and in one or two Russian localities.

PRODUCTUS ARCUARIUS, De Koninck. Pl. XXXIV, fig. 17.

PRODUCTUS ARCUARIUS, De Kon. Descript. du Animaux foss. du terrain Carb. de la Belgique, p. 171, pl. xii, fig. 10^{a, b}, 1843, and Mon. du genre *Productus*, pl. iv, fig. 2.

Spec. Char. Shell small, transversely oval; hinge-line much shorter than the greatest width of the shell. Ventral valve almost hemispherical and regularly vaulted up to a certain distance or age, when it is again continued under the shape of a wide, prominent border, separated from the rostral half by a groove, which, originating on either side of the beak, curves round the valve. The margin is also sometimes bent up at right angles, and thus forms a flattened rim all round the shell. Beak and auricular expansions small. Surface ornamented by numerous radiating, thread-like striæ, which become more numerous by interstriation, and are here and there swollen out, giving rise to a variable number of slender, tubulated spines, which are more numerous on the ear-shaped expansions. Dorsal valve concave, following the curves of the ventral one, and similarly ornamented. Interior unknown. Dimensions variable; a British example measured—length $5\frac{1}{2}$, width 8 lines.

Obs. This little shell does not appear very rare in the Carboniferous limestone of Settle, in Yorkshire, where it was discovered for the first time in Britain by Mr. Burrow. Having submitted specimens to Prof. de Koninck, he declared them to be specifically identical with those from Visé, in Belgium. The concentric groove which divides the ventral valve into two portions is not, however, always so distinctly marked in the British specimens that have come under my observation as in certain Belgian individuals figured by Prof. de Koninck.

PRODUCTUS CARBONARIUS, De Koninck. Pl. XXXIV, fig. 6.

PRODUCTUS CARBONARIUS, De Koninck. Descrip. des Animaux foss. der terr. Carb. de la Belgique, pl. xii^{bis}, fig. 1, 1843, and Mon. du genre *Productus*, pl. x, fig. 4, 1847.

— — *De Verneuil.* Russia and Oural Mountains, pl. xvi, fig. 2, 1845.

— — *Dav.* A Mon. of the Carb. Brachiopoda of Scotland, pl. iv, fig. 14, 1860.

Spec. Char. Shell of median size, about as wide as long, or slightly transverse; ventral valve very gibbous, evenly rounded, and without sinus; auriculate expansions small; hinge-line nearly as wide as the greatest width of the shell. Surface ornamented with very fine, thread-like, radiating striæ, from which project at short intervals numerous slender spines, the rib becoming thickened at the spot where the spine originates; beak small, much incurved, and covered with a few slight concentric wrinkles. Dorsal valve following

the curves of the opposite one, and similarly ornamented. Interior unknown. A British specimen measured—length $9\frac{1}{2}$, width 11, lines.

Obs. I am acquainted with but a single British example of this species, stated to have been found in Carboniferous limestone north of Glasgow (?) and now preserved in the museum of Practical Geology. The identification is given on the authority of Prof. de Koninck, and it would be very desirable that more specimens should be obtained and examined before its specific claims be definitely recognised. Our Scottish example agrees, however, very nearly with the figure published by Prof. de Koninck of a specimen found in a calcareous nodule at Chokier, in Belgium, and M. de Verneuil states he has obtained the species in a Carboniferous limestone in the valley of Prikcha (Valdai), Russia.

PRODUCTUS UNDATUS, *Defrance*. Pl. XXXIV, figs. 7—13.

PRODUCTUS UNDATUS, *Defrance*. Dic. des Sc. nat., vol. xliii, p. 354, 1826.

- — *De Koninck*. Desc. des Animaux foss. du Terrain Carb. de Belgique, p. 156, pl. xii, fig. 2, 1843; and Mon. du genre Productus, pl. v, fig. 3.
- TORTILIS, *McCoy*. Synopsis of the Carb. Foss. of Ireland, tab. xx, fig. 14, 1844.
- UNDATUS, *De Verneuil*. Russia and the Ural Mountains, vol. ii, p. 261, pl. xv, fig. 15, 1843.
- — *Dav.* Mon. Scottish Carb. Brach., p. 41, pl. iv, figs. 15—17, 1860.

Spec. Char. Shell somewhat sub-orbicular or slightly transverse; hinge-line rather less than the width of the shell. Ventral valve regularly vaulted, very convex, without sinus; beak small, rounded, incurved, not extending much beyond the hinge-line; auriculate expansions small. Surface covered with numerous irregular or interrupted sub-parallel, undulating, concentric folds or wrinkles, which become wider and more produced with age, and having their narrow, almost perpendicular, side directed towards the beak; the valve is, moreover, ornamented by numerous minute, rounded, thread-like striæ, separated by narrow sulci, and of which from five to six may be counted in the thickness of a line, and swelling out at intervals, they give rise to a slender spine. Dorsal valve concave, following the curves of the opposite one, and similarly ornamented. Interior unknown. Dimensions variable; two British examples have measured—

Length 14, width 13, lines.

„ 12, „ 13, „

Obs. This remarkable species, although not common, is by no means very rare in the Carboniferous limestone of Great Britain, and may be easily distinguished from other British Producta by that curious terrace-shaped or crumpled-like appearance it presents, and which is caused by the numerous concentric wrinkles which cover the surface of both

valves. In some specimens these ridges are very regular and uninterruptedly continuous, but in the larger number of individuals some of them are here and there interrupted in their course and absorbed, while two at other times unite during their passage along the middle. The radiating thread-like striæ bear much resemblance to those of *P. Cora*, and increase in number here and there by interstriation.

In England, *P. undatus* occurs in the lower scar limestone of Settle, in Yorkshire, in the lower Carboniferous limestone of Lowick, Northumberland, middle limestone of Poolwash, Isle of Man, and upper Carboniferous limestone of Derbyshire. In Scotland, it occurs in limestone at Gare and Headsmuir, at about 240 fathoms below the horizon of the "Ell Coal." In Stirlingshire, in the Campsie main limestone, and at Castlecarry, in Dumbartonshire. In Ireland, at Tullynagaigy, Fermanagh, and at Little Island, near Cork.

On the Continent, it occurs in the limestone of Visé, in Belgium, and at D'Unja, near Kosimof, as well as at Nikoulin and Karova, in Russia. M. de Koninck mentions also that a specimen is preserved in the Museum of Paris, found in Tasmania.

PRODUCTUS WRIGHTII, *Dav.* Pl. XXXIII, figs. 6, 7.

Spec. Char. Shell small, transversely oval; hinge-line rather less than the width of the shell. Ventral valve convex and regularly vaulted; beak and auriculate expansions small. Surface covered with numerous smooth, regular or irregularly interrupted, undulating, concentric folds or wrinkles, from which, at short intervals, project scattered spines; the margin of the valve is, moreover, bent up at right angles, forming a wide, flattened, but ribbed boarder or frill round the shell. Dorsal valve and interior unknown. The largest specimen hitherto discovered measures—length $3\frac{1}{2}$, width 5 lines, of which the bent-up margin is from 1 to $1\frac{1}{2}$ line in width.

Obs. Of this interesting little species two examples were discovered by Mr. J. Wright in the Carboniferous limestone of Middleton, near Cork, in Ireland, and have been considered by Prof. de Koninck, as well as by myself, a new species (?) The concentric folds or wrinkles resemble much those of *P. undatus* in their terrace-like arrangement, but are distinguished by the total absence of those longitudinal, thread-like striæ so beautifully disposed in DeFrance's species; the wide fringe or frill which surrounds the shell is also peculiar.

The species is named after Mr. Joseph Wright, to whom the author of this monograph is indebted for much valuable material and information relative to the species from the neighbourhood of Cork, in Ireland.

PRODUCTUS PROBOSCIDEUS, *De Verneuil*. Pl. XXXIII, figs. 1—4.

PRODUCTUS PROBOSCIDEUS, *De Verneuil*. Bulletin de la Soc. Geol. de France, vol. xi, p. 259, pl. iii, fig. 3, 1840.

CLAVAGELLA PRISCA, *Goldfuss*. Petref. Germ., vol. ii, p. 285, pl. clx, fig. 17, 1841.

PRODUCTUS PROBOSCIDEUS, *V. Buch*. Abhand. der. K. Akad. der Wissens. zu Berlin, Erster Theil., p. 40, 1841.

— — — *De Koninck*. Descript. des Animaux foss. du Terrain Carb. de Belgique, p. 11, fig. 4, 1843; and Mon. du genre Productus, pl. vi, fig. 4 *a, b, c, d*, 1847.

Spec. Char. Shell of moderate size, and very variable in shape, on account of the singular prolongation of its ventral valve. Dorsal valve small, gently and regularly concave; slightly transverse or elongated, with a straight hinge-line always shorter than the greatest width of the shell. Surface covered with fine, radiating, thread-like striæ, intersected by numerous concentric wrinkles. The ventral valve is composed of two well-marked parts; the first (which corresponds with almost the entire dorsal valve) is marginally somewhat circular, moderately convex, and about as wide as long, the beak being very small and but slightly incurved over the hinge-line of the opposite valve. Auriculate expansions small. The second portion is composed of a general prolongation of the margin of the same valve, which commences by the lateral portions extending on either side, and, by gradually forcing open the smaller valve, unite round its margin, to be prolonged afterwards in the shape of a cylindrical tube of lesser or greater length. This tube is concentrically wrinkled, and irregular in width and direction, while the surface of the entire valve is minutely striated, and numerous long, slender spines rise and project forwards from the lateral expansions of the ventral valve. Interior unknown. Proportions very variable; two British examples have measured

Ventral valve, entire length, with tube, $13\frac{1}{2}$, width 5, lines.

Dorsal valve " " 4, " $4\frac{1}{2}$, "

Another example measured—

Ventral valve, entire length, with tube, 11, width $4\frac{1}{2}$, lines.

Dorsal valve " " 3, " $3\frac{1}{2}$, "

Obs. This Productus is one of the most remarkable of the genus, and its discovery by Mr. Burrow in the Carboniferous limestone of Settle, in Yorkshire, was the more interesting from the fact that authentic examples of the species had not until then been found in any other locality than Visé, in Belgium.¹ The shell has been fully described and

¹ Another form, (?) nearly related by shape to that under description, has been described and figured by Messrs. Norwood and Pratten from the Carboniferous rocks of Graysville, Illinois, America, under the denomination of *P. clavus*, but which is stated by these palæontologists to "differ from *P. proboscideus*, with which alone it can be confounded, in the longitudinal ribs not extending over the visceral portion, and in the prolongation not showing the numerous and well-marked transverse folds of that species. The

illustrated by Messrs. de Verneuil and de Koninck, who state that, although the tube was generally simple, it sometimes bifurcated, and then two independent tubes were produced. Its direction is generally that of the longitudinal axis of the shell, but it is often irregularly twisted to the one or the other side, and may likewise remain straight for some time before suddenly bending and assuming another direction, as represented in one of the specimens figured in my plate. The tube has also attained at times considerable length, one Belgian example figured by Prof. de Koninck being nearly two inches in length, with not more than four lines in width, and although the specimen was broken and imperfect at its extremity, the width had not altered in all its length. M. de Koninck has also observed that he has never been able to procure a single specimen in which the tube was complete, and therefore concludes that its extremity was open, and served for the passage of muscular fibres, by which the animal attached itself to submarine objects. But, as I have already had occasion to observe at p. 119 of my "General Introduction," I feel compelled to differ with my learned friend in this last assumption. M. d'Orbigny believed the prolongation to be due to malformation produced by accidental circumstances, connected with the supposed constrained position in which the animal lived, which forced the mantle to prolong its edges so as to reach the surface of the sea-bed; but in the localities in which the form is found a vast number of other species of the genus occur, which do not present this peculiarity, so that we must regard the structure as *normal*, although M. d'Orbigny's explanation of its function is probably correct; and in any case I cannot concur in the supposition that the shell may have been fixed to submarine bodies by the means of muscular fibres issuing from the open extremity of the tube. The prolongation of the ventral valve beyond that of the dorsal one is not a feature peculiar to the shell under consideration, for it has been noticed already in two or three more species of the same genus, as well as in a Liassic form of *Thecidium*, where the ventral valve is prolonged much beyond that of the dorsal one.

The two parts of which the ventral valve is composed are clearly defined by the means of a groove.

PRODUCTUS ERMINEUS, *De Koninck*. Pl. XXXIII, fig. 5.

PRODUCTUS ERMINEUS, *De Koninck*. Descript. des Anim. foss. du Terr. Carb. de Belgique, p. 181, pl. x, fig. 5, 1843; and Mon. du genre *Productus*, pl. vi, fig. 5, and pl. xviii, fig. 1.

Spec. Char. • Shell of moderate dimensions, longer than wide; hinge-line much

longitudinal ribs of *P. proboscideus* are also much finer, numbering about fifty in the space of ten millimètres at the interior border of the visceral part. *P. clavus* shows no trace of sinus." It must, however, be remembered that the American specimen is stated to have been in so imperfect a state of preservation that for some time the authors hesitated in including it in their memoir, and it is still possible that *P. clavus* may, after all, belong to M. de Verneuil's curious species (?).

shorter than the greatest width of the shell. Ventral valve gently convex from the extremity of the beak to the front, the lateral portions being much extended and bent downwards at almost right angles to the plane of the valve; beak and auriculate expansions small, with a ridge commencing at their extremity, extending to some distance on either side, thus dividing the visceral from the labial extensions of the valve. The surface is covered with numerous thread-like, radiating striæ, which increase in number by interstriation at various distances from the beak, from which project a few scattered spines; it is also ornamented by many concentric, undulating wrinkles, which become larger or wider as they recede from the extremity of the beak. The dorsal valve is concave, following closely the curves of the opposite one, and is similarly ornamented. Interior like that of other Producta. A British example measured—

Length 10, width $9\frac{1}{2}$, lines.

Obs. This species differs from *P. proboscideus*, by its dorsal valve following exactly the curves of the ventral one, and by the last-named valve not being prolonged in the form of a cylindrical tube. It occurs in the Carboniferous limestone of Settle, in Yorkshire, where it was found for the first time in England by Mr. Burrow, and is there associated with *P. proboscideus*, as well as at Visé, in Belgium, the only two localities in which the species has been hitherto discovered.

PRODUCTUS TESSELLATUS, *De Koninck*. Pl. XXXIII, figs. 24, 25; Pl. XXXIV, fig. 14.

PRODUCTUS MURICATUS, *De Koninck*. Descript. des Animaux foss. du Terr. Carb. de Belgique, p. 192, pl. ix, fig. 2; pl. 13^{bis}, fig. 5 (not Phillips), 1843.

PRODUCTUS TESSELLATUS, *De Koninck*. Monographie du genre Productus, Mémoires de la Soc. Royale des Sciences de Liège, vol. iv, pl. xiv, fig. 2, 1847.

— — — *Morris*. Catalogue, p. 145, 1854.

Spec. Char. Shell small, transversely oval, a little wider than long; hinge-line much shorter than the width of the shell. Ventral valve evenly convex and regularly vaulted, without sinus; beak small, prominent, and incurved, not projecting beyond the hinge-line; auriculate expansions very slightly developed. Surface ornamented by from fifteen to twenty round, salient costæ, from which project a few scattered spines, and intersected by about as many concentric grooves; margin bent upwards, wide, flat, or slightly concave, and marked by numerous rounded, bifurcated, or trifurcated ribs, with dorsal valve gently concave, and ornamented as in the ventral one. Interior unknown. Dimensions variable; two British examples have measured—

Length 11, width 12, lines.

„ 6, „ $8\frac{1}{2}$, „

The flattened border is nearly one third of the entire length of the valve.

Obs. This elegant shell appears rare in British Carboniferous rocks, but is easily distinguished from other forms of the genus by shape and sculpture, as well as by the flattened, ribbed border which encircles the valves. In England it has been found by Mr. Burrow in the Calcareous limestone of Settle, in Yorkshire, by the Rev. T. G. Cumming in the Isle of Man, while in Ireland it occurs in the Calcareous limestone of Kildare. On the Continent it is not very common at Visé, in Belgium.

PRODUCTUS ACULEATUS, Martin. Pl. XXXIII, figs. 16—20.

ANOMITES ACULEATUS, Martin. Petrif. Derbiensis, p. 8, pl. xxxvii, figs. 9, 10, 1809, (not Schlotheim).

PRODUCTUS ACULEATUS, Sow. Min. Con., tab. lxviii, fig. 4, Oct., 1814.

PRODUCTA LAXISPINA, Phillips. Geol. of York., pl. viii, fig. 13, 1836.

PRODUCTUS SPINULOSA, Phillips. Ib., vol. ii, pl. vii, fig. 14 (not of Sow.), 1836.

— *GRYPHOIDES, De Koninck.* Desc. des Anim. foss. du Terrain Carb. de la Belgique, pl. ix, fig. 1, and pl. xii, fig. 12, 1843 (?)

— *ACULEATUS, De Koninck.* Mon. du genre *Productus*, pl. xvi, fig. 6, 1847.

— — *M'Coy.* British Palæozoic Fossils, p. 458, 1855.

— — *Dav.* Mon. of Scottish Carb. Brach., pl. ii, fig. 20, 1860.

Spec. Char. Shell of moderate dimensions, ovate or semicircular, slightly transverse or elongated; hinge-line less than the width of the shell. Ventral valve regularly vaulted, gibbous, without sinus; beak much incurved and overlying the hinge-line at its attenuated extremity; auriculate expansions small and thin. Surface in the young shell covered with a variable number of irregularly scattered, elongated tubercles, from which project small, curved spines, but with age the tubercles are at times so close and elongated on the anterior half of the valve that they become transformed into longitudinal ribs; the surface is moreover intersected by regular or undulating laminar, concentric lines. Dorsal valve very concave, following closely the curves of the opposite one, and similarly ornamented. Interior unknown. Dimensions variable; three British examples have measured—

Length 6, width $6\frac{1}{2}$, lines (Martin's type).

„ 11, „ 12, „

„ 11, „ 13, „

Obs. In general appearance this *Productus* varies considerably, according to age and specimen, Martin's type (of which I have given a carefully enlarged representation) having been described and drawn from a young shell, which was almost smooth, from the very few, irregularly scattered, tubular spines which covered its surface;¹ but in other specimens, with

¹ Martin describes his species—"A fossil shell. Original an *Anomia*, imperforate, with one of the valves concave, the other convex and gibbous. Hinge close, straight, but less extended than in most other *Anomitæ* of the same division (Syst. G. B., '*Anomitæ*,' b, b). The convex valve prickly; the

age the tubercles became closer and closer, until converted into ribs, the posterior half of the valves usually preserving the characters of the young shell. Martin describes the spines as pointed backwards towards the beak, but this observation has already been shown by Prof. de Koninck and M'Coy to have been erroneous, their direction being similar to that of other *Producta*. *P. laxispina* of Phillips has been drawn from a large example of Martin's species, and the *P. spinulosa*, Phillips (but not of Sow.), would appear to be likewise referable to the same species.

P. aculeatus is a common shell in many localities. In England, it occurs in Carboniferous limestone at Bakewell, Buxton, and Chrome Hill, Longnor, in Derbyshire; at Settle, in Yorkshire; Bolland, in Westmoreland; Lowick, Northumberland; in the middle limestone of Poolwash, Isle of Man, &c. In Scotland, at Calderside; High Blantyre, in Lanarkshire; Orchard Quarry, Thornliebank, Renfrewshire; at West Broadstone, Beith, in Ayrshire; as well as at Craigie, near Kilmarnock, and Auchenskey, near Dalry, in the same county. In Ireland, in limestone at Lisnapaste, Howth, Old Leighlin, Little Island, and Windmill.

On the Continent, it occurs at Visé, in Belgium. In Russia it has been found in several localities, such as in the neighbourhood of Buregi, Government of Nowgorod, as well as at Cosatchi-Datchi, on the Oriental side of the Oural, to the east of Minsk, &c.

PRODUCTUS YOUNGIANUS, *Dav.* Pl. XXXIII, figs. 21—23.

PRODUCTUS YOUNGIANUS, *Dav.* Mon. of Scottish Carb. Brach., pl. ii, fig. 26, and pl. v, fig. 7, 1861.

Spec. Char. Shell longitudinally oval; hinge-line shorter than the width of the shell. Ventral valve regularly arched, convex, and without sinus; auriculate expansions very small; beak incurved and comparatively large, not overlying the hinge-line except quite at its attenuated extremity. Dorsal valve very concave, following closely the curves of the opposite one. Surface in both valves ornamented with numerous small, rounded ribs, of which a certain number are due to intercalation, and from which, at short distances, project slender, tubular spines, more widely scattered in some specimens than in others; the valves are also covered with irregular, undulating, squamiform, concentric expansions, which overlap each other very numerously in some examples, sparingly in others. In the interior the muscular and reniform expansions are similar to those of other *Producta*. Dimensions variable; two British examples have measured—

Length 13, width 9, lines.

„ 9, „ $6\frac{1}{2}$, „

Obs. This shell appears distinguishable from *P. aculeatus* by its more regularly oval

prickles few, scattered, very minute, short, appressed, or squeezed flat to the surface, and pointing backwards or towards the beak. The beak small and hooked. It is found near Bakewell and Buxton.”

and elongated appearance, its ribs being likewise more numerous and regular, both in the young and adult condition, than what is usually observable in Martin's species. In this opinion I am supported by Prof. de Koninck and Mr. Young, but am still somewhat uncertain whether the shell under description is in reality more than a variety of Martin's species.

In Scotland, *P. Youngianus* occurs abundantly in a white friable shale above a coralline bed (*Lithodendron fasciculatum*, Fleming, *Lithostroton Martini*, M. Edwards). It is found also at Brockley, near Lesmahago, in Lanarkshire, as well as in Renfrewshire, Ayrshire, and Fifeshire.

In England in Carboniferous limestone at Llangollen, in Wales.

PRODUCTUS PUSTULOSUS, *Phillips*. Pl. XLI, figs. 1—6 ; Pl. XLII, figs. 1—4.

PYXIS TRANSVERSIM STRIATA, *Chemnitz*. Martini's Neues Syst. Conch. Cabinet, vol. vii, p. 301, pl. lxiii, figs. 605 and 606, and vol. viii, fig. 69, 1784.

PRODUCTA PUSTULOSA, *Phillips*. Geol. of Yorks., vol. ii, p. vii, fig. 15, 1836.

— RUGATA, *Phillips*. Ib., fig. 16.

— OVALIS, *Phillips*. Ib., pl. viii, fig. 14.

PRODUCTUS PUSTULOSUS, *De Koninck*. Desc. des Anim. foss. du Terr. Carb. de Belgique, pl. xii^{bis}, fig. 3, 1843.

— PUNCTATUS, *Kon.* (non Martin). Ib., pl. ix, fig. 6.

— PUSTULOSUS, *Kon.* Mon. du genre Productus, pl. xiii, fig. 1, and pl. xvi, figs. 8, 9, 1847.

— PYXIDIFORMIS, *Kon.* Ib., pl. xi, fig. 7 ; pl. xii, fig. 1 ; pl. xvi, fig. 2.

Spec. Char. Shell thin, rotundato-quadrate, wider than long, rarely oval and longer than wide ; hinge-line shorter than the greatest width of the shell. Ventral valve regularly arched and gibbous, divided longitudinally by a sinus of greater or lesser depth and width ; beak moderately developed and incurved, not overlying the hinge-line except at its attenuated extremity ; ears wide, nearly rectangular, and flattened ; margin slightly indented in front. External sculpture varying somewhat in appearance in different specimens, but usually covered with numerous continuous or interrupted transverse, undulating wrinkles, while numerous pustules or elongated tubercles, bearing slender, tubular spines, are subquincuncially arranged or disposed in irregular rows over the entire surface. Dorsal valve slightly concave, with a small mesial elevation or fold, while numerous transverse wrinkles, tubercule-pits, and short spines, cover the surface. Dimensions variable ; three examples measured—

Length 44, width 46, greatest depth between valves 17, lines.

„ 28, „ 39, „ „ „ 10, „

„ 24, „ 20, „ „ „ 8, „

Obs. After a lengthened comparison and study of more than one hundred specimens

of the shell under description, there can exist but little doubt that *P. rugata*, *P. ovalis*, and *P. pyxidiformis*, are merely different states of *P. pustulosus*, and I quite coincide with Professor M'Coy when stating that "scarcely any two examples of *P. pustulosus* agree in the strength or directness of the transverse ridges; in specimens perfectly typical in this respect near the beak, the ridges will be often found indistinct, undulated, and interrupted on other parts, and when this is the case the tubercles generally increase in size and become quincuncially arranged. I have traced the passage from the most regularly wrinkled type (like Koninck's figure, op. cit., t. xii, fig. 4), with the spines on the summits of the transverse ridges, through those in which the spines do not coincide with the (still well-marked) ridges (like his t. xvi, fig. 9), to those in which the wrinkles gradually become irregular, interrupted, and nearly obsolete, as in *P. pyxidiformis*, by the most imperceptible gradations. In all these varieties the isolation of the tubercles, instead of their being mere inflations of distinct, longitudinal striæ or ridges, distinguishes the species from the true *P. scabricula*." I have never yet obtained a perfect specimen of the shell under description, for in all the British examples the spines were broken close to their base.

The interior has been sometimes obtained, and of which figures are given in my plate. In the umbonal portion of the ventral valve the occlusor or adductor scars are placed on either side of a small ridge between and on a level with the cardinal or divaricator impressions. In the dorsal valve the adductor and riniform impressions do not differ much in detail from what we find in the generality of *Producta*. *P. pustulosus* is not rare in the Carboniferous limestone of many English localities, such as Bolland, Settle, Kendal, the Isle of Man, in Derbyshire, &c. In Scotland it has been stated to occur at Cat Craig, near Dunbar. In Ireland in the Calciferous slate and Carboniferous limestone of Bundoran, Ballyduff, Carrigaline, Lisnapaste, Millecent, Tankardstown, Florence Court, Little Island, shores of Lough Gill, valley of the Maine, Hook, St. Doolas, near Dublin, &c.

On the Continent it occurs at Visé and Tournay, &c., in Belgium; Ratingen (Prussia); and it has also been found in America.

PRODUCTUS SCABRICULUS, *Martin*. Pl. XLII, figs. 5—8.

ANOMITES SCABRICULUS, *Martin*. Petrif. Derby., p. 8, pl. xxxvi, fig. 5, 1809.

PRODUCTUS — *Sow.* Min. Conch., t. lxix, fig. 1, Oct., 1814.

PRODUCTA SCABRICULA, *Phill.* Geol. of York., vol. ii, pl. viii, fig. 2, 1836.

— QUINCUNCIALIS, *Phill.* Ib., pl. vii, fig. 8.

— SCABRICULUS, *De Koninck*. Desc. des Anim. foss. du Terrain Carb. de Belg., pl. xi, fig. 3 ^{a, b} (?), 1843; and Mon. du genre Productus, pl. xi, fig. 6, 1847.

— CORBIS, *Potiez et Michaud*. Galer. des Mollusques du Mus. de Douai, vol. ii, pl. xli, fig. 2, 1844.

— SCABRICULUS, *De Verneuil*. Russia and the Ural Mount., pl. xvi, fig. 5; and pl. xviii, fig. 5, 1845.

— — *M'Coy*, British Pal. Fossils, p. 470, 1855.

— — *Dav.* Scottish Carb. Brach., pl. iv, fig. 18, 1861.

Spec. Char. Marginally rotundato-quadrate, generally wider than long, lateral margins sub-parallel; rounded or slightly indented in front; hinge-line rather less than the greatest width of the shell. Ventral valve convex, with a wide, shallow, median depression or sinus; beak incurved, not overlying the hinge-line, except at its attenuated extremity; ears small, flattened. Surface covered with numerous sub-regular striæ, swelling out at close intervals in the shape of oblong tubercles, arranged somewhat irregularly in quincunx, and from each of which rise slender, curved spines, of rather less than half an inch in length; feeble concentric wrinkles sometimes traverse the valve, and are especially marked on the ears. Dorsal valve concave, near the margin, with a slight median elevation commencing not far from the front; surface covered with numerous concentric wrinkles, tubercle-pits, and short, depressed, slender spines. Dimensions variable; two British examples measured—

Length $28\frac{1}{2}$, width $33\frac{1}{2}$ lines.

„ 12, „ 12 „

Obs. Variations in shape of this shell have received different names, and it has been sometimes suggested that it and the preceding species should be united.¹ Professor de Koninck mentions that it bears much resemblance with the young state of his *P. pyxidiformis*, and that it approaches likewise to *P. Humboldtii*, and I am ready to admit that a certain external resemblance does sometimes exist among certain examples of these species. In true *P. scabriculus* the swollen-out, alternating, elongated tubercles are connected by a continued ridge, so that the shell has the appearance of being ribbed, while in *P. pustulosus* the tubercles are more often isolated. The interior, however, in the dorsal valve presents a difference in the shape of the median ridge, which extends from under the cardinal process and divides the adductor impression. In *P. pustulosus* this ridge is simple, while in *P. scabriculus* it is composed of two ridges, which converge and unite at some distance from their origin into a single ridge (fig. 8). I have observed this character in several examples, and believe it constant.

P. scabriculus is common in the Carboniferous limestone of the Craven district, and Settle, in Yorkshire; near Bolland; in dark Carboniferous limestone at Lowick, Northumberland; Martin found it in the limestone of Tideswell, in Derbyshire. It is not uncommon at Coalbrook Dale; near Bristol, &c. In Scotland, it is plentiful in ironstone at Jock's Burn, Braidwood, Brockley, and many other Lanarkshire localities. In Stirlingshire it occurs in several stages, such as the Craigenglen beds, Campsie main-limestone and ironstone, and at Corrieburn. It has also been found in Renfrewshire, Dumbartonshire, Ayrshire, the Lothians, and Fifeshire. In Ireland, Mr. Kelly mentions that it occurs in the Calcareous slate and Carboniferous limestone of Lisnapaste, Millecent, Little Island, and of, no doubt, many other localities. It is also a common fossil on the Continent, having been found at Visé, in Belgium; Peredki (Valdaï), Sloboda, &c., in Russia. Specimens have also been collected in America, &c.

¹ Explanations to accompany sheets 102 and 112 of the maps of the Geological Survey of Ireland, p. 16.

PRODUCTUS FIMBRIATUS, *J. de C. Sowerby*. Pl. XXXIII, figs. 12—15, and Pl. XLIV, fig. 15.

ANOMITES PUNCTATUS, *Martin*. Petrif. Derb., pl. xxxvii, figs. 7, 8 (fig. 6 exclusiva), 1809.

PRODUCTUS FIMBRIATUS, *J. de C. Sow*. Min. Conch., pl. 459, fig. 1, July, 1823.

STROPHOMENA MARSUPIT, *Davreux*. Const. Geogn. de la province de Liege, pl. iv, fig. 2 A, B, 1833.

PRODUCTA FIMBRIATA, *Phillips*. Geol. of York., vol. ii, pl. viii, figs. 11, 12, 1836.

— — *V. Buch*. Abhandl. der K. Akad. der Wissens. zu Berlin, Theil i, p. 27, pl. ii, figs. 21—23, 1841.

— — *De Koninck*. Desc. des Animaux foss. du Terr. Carb. de Belgique, pl. x, fig. 3 *a, b, c, d*, 1843; and Mon. du genre Productus, pl. xii, fig. 3 *a, b, c*, 1847.

? PRODUCTA LACINIATA, *M'Coy*. Synopsis of the Carboniferous Fossils of Ireland, pl. xx, fig. 12, 1844.

PRODUCTA FIMBRIATA, *M'Coy*. British Palæozoic Fossils, p. 461, 1855.

— — *Dav*. Mon. of Scottish Carb. Brach., pl. ii, fig. 27, 1860.

Spec. Char. Longitudinally oval or ovate; hinge-line a little shorter than the width of the shell. Ventral valve uniformly convex, gibbous, and greatly arched in profile; beak much incurved, overlying the hinge-line at its attenuated extremity; ears small and but slightly marked. Surface regularly traversed by numerous sub-regular, concentric, prominent bands or ridges, with flattened, intervening spaces; a row of elongated tubercles covering each ridge, and from which project long, tubular, cylindrical spines. Dorsal valve nearly flat or moderately concave, traversed by numerous concentric ridges, with concave interspaces; a row of short, adpressed spines projecting from every ridge. Dimensions variable; two specimens have measured—

Length 18, width 17, greatest depth between valves 9 lines.

„ 15, „ 12, „ „ „ 7 „

Obs. This species does not attain the proportions of *P. punctatus*, is less variable in its shapes, possesses no sinus, and is especially distinguished by the single row of cylindrical spines which rise from each row of elongated tubercles, as above described. With *P. laciniata*, M'Coy (Pl. XLIV, fig. 15), I am not sufficiently acquainted. It has been supposed by some a synonym of *P. punctatus*, but the study of two Irish examples leads me almost to agree with M'Coy while stating that it bears more resemblance to *P. fimbriatus*, of which it is possibly only a variety or variation in shape, more transverse, with a greater number of concentric ridges, smaller and more numerous elongated tubercles or cylindrical spines.¹ This I must, however, leave as an open question for the present. The interior of the dorsal valve of *P. fimbriatus* alone is at present

¹ At p. 110 of the 'Synopsis,' M'Coy describes his *P. laciniata* as "nearly semicircular, length one sixth less than the width; hinge-line rather less than the width of the shell; moderately convex; beak small, prominent; ten or twelve rounded, concentric wrinkles, fringed on their marginal declivity with close, regular, lengthened spine-bases. Length eleven lines; width one inch one line." Fig. 15 of our 44th plate is taken from the original specimen.

known, and appears to present certain peculiarities which have been carefully represented in the figures of my plate. Thus, the adductor muscular impressions are very much produced, and form two pairs of contiguous projections, separated by a short median ridge which extends to nearly the centre of the valve, where it becomes much elevated, with a depression or pit on either side, margined by a vertical wall, as in *Strophomena analoga* and some other species. The reniform impressions are also much more oblique in their direction than is usual to the species of this genus. In the greater number of specimens the spiniferous ridges are separated by almost smooth spaces, but in some rarer examples the tubercles or spine-bases are so much elongated as to give the surface somewhat the appearance of certain examples of *P. scabriculus*.

P. fimbriatus is not uncommon in the Carboniferous limestone of Derbyshire, of Lowick, Northumberland; limestone and shale of Settle, in Yorkshire; Bolland; Poolwash, Isle of Man, &c. In Scotland at Hillhead, at Middleholm, Lanarkshire; Gateside and West Broadstone Beith, Ayrshire; in Fifeshire, &c. In Ireland, at Little Island, Bundoran, Tornaroan, &c. In Belgium it is common in the lower stage of the Carboniferous system of Visé, rare in that of Chockier; and has been found also at Sterlitamak, in Russia, &c.

PRODUCTUS PUNCTATUS, Martin. Pl. XLIV, figs. 9—16.

- ANOMITES PUNCTATUS, *Martin*. Petrif. Derb., pl. xxxvii, fig. 6 (7, 8 exclusa), 1809.
 TRIGONIA RUGOSA, *Parkinson*. Organ. Remains, vol. iii, pl. xii, fig. 11, 1811.
 ANOMITES THECARIUS, *Schloth*. Nachtr. zur Petrefactenk., pl. xiv, fig. 1, 1822.
 PRODUCTUS PUNCTATUS, *J. Sow*. Min. Conch., t. 323, Jan., 1822.
 PRODUCTA PUNCTATA, *Phillips*. Geol. of York., vol. ii, pl. viii, fig. 10, 1836.
 LEPTÆNA SULCATA, *Fischer*. Oryct. du Gouv. de Moscou, pl. xxiii, fig. 2 (non Sow.), 1837.
 PRODUCTUS PUNCTATUS, *V. Buch*. Abhandl. der K. Akad. der Wissens. zu Berlin, Thiel. i, pl. ii, figs. 10, 11, 1841.
 — — — *De Kon*. Desc. des Animaux foss. du Terr. Carb. de Belgique, pl. viii, fig. 4; pl. x, fig. 2; pl. ix, fig. 4, 1843; and Mon. du genre Productus, pl. xii, fig. 2, 1847.
 — CONCENTRICUS, *Potiez et Michaud*. Galer. des Mollusques du Mus. de Douai, vol. ii, p. 25, pl. xli, fig. 1, 1844.
 — PUNCTATUS, *De Vern*. Russia and the Ural Mountains, vol. ii, pl. xvi, fig. 11, 1845.
 — TUBULOSPINA, *M^cChesney?* Desc. of New Species of Fossils from the Palæozoic Rocks of the Western States, p. 37, 1859.
 — PUNCTATUS, *Dav*. Scottish Carb. Mon., pl. iv, fig. 20, 1860.

Spec. Char. Shell thin, variable in shape; transversely rotundato-quadrate, or slightly elongated oval; hinge-line shorter than the width of the shell. Ventral valve convex, sometimes gibbous, with a shallow, longitudinal, mesial depression or sinus, commencing at a short distance from the extremity of the beak and extending to the front; beak incurved, overlying the hinge-line at its attenuated extremity; ears flattened, but slightly defined.

Surface covered with numerous sub-regular, concentric bands or ridges, which increase in number and breadth as they recede from the extremity of the beak, but in adult shells becoming again closer as they approach the margin; these bands (in the ventral valve) are slightly raised towards their lower margin, and are abruptly separated from each other by a narrow, smooth space, after which there exists a tolerably regular row of lengthened tubercles or slender, shining, tubular spines, and again below these the remaining space is filled up by irregularly scattered, but closely packed, smaller spines, all overlapping one another, and lying close to the valve. Dorsal valve moderately concave, with a slight mesial elevation, and ornamented as in the dorsal one, but the bands are slightly concave. In the interior of the ventral valve the adductor or oclclisor muscular impressions extend much lower down in the shell than do those attributable to the divaricators. In the dorsal valve the muscular and reniform impressions differ but slightly from those of other *Producta*. Two specimens have measured—

Length 28, width 31, greatest depth between valves 12 lines.

„ 29, „ 23, „ „ „ 11 „

Obs. This common and very characteristic species appears to have been described and figured for the first time by David Ure, who mentions that “both valves are covered with small spines resembling hair, and so numerous that a largish example contains upwards of ten thousand, and lie so closely together that the surface of the shell is entirely concealed from view,”¹ but it is rare to find the specimens in that condition, the valves being usually deprived of their spiny investment. Martin appears, however, to have been the first naturalist who applied to the shell a specific denomination, but he confounded under the same name the *P. fimbriatus* of Sowerby, a closely allied, but easily distinguishable species.

Productus elegans has been generally considered a synonym or a young condition of the shell under description; but as I am still uncertain whether it be really so or a distinct species, as believed by M'Coy, it will therefore be preferable to describe it separately, but, perhaps, as a variety of *P. punctatus*, to which it bears much resemblance in the arrangement of its spines. *P. punctatus* is characterised in all well-shaped examples by a median depression or sinus, but as this commences usually at a short distance from the extremity of the beak it has been supposed, correctly or erroneously, that in the young state the ventral valve may have been convex and without sinus (?).

Var? *ELEGANS*, M'Coy. Pl. XLIV, fig. 15.

PRODUCTUS ELEGANS, M'Coy. Synopsis Carb. Foss. Ireland, pl. xviii, fig. 13, 1844; and British Palæozoic Fossils, p. 460, pl. iii H, fig. 4.

Shell rather small, longitudinally ovate; hinge-line a little shorter than the width of the valve. Ventral valve regularly arched and gibbous, without sinus. Surface crossed

¹ ‘History of Rutherglen and East Kilbride,’ pl. xv, fig. 1, 1793.

by from ten to sixteen regular broad, sub-equal, transverse ridges, obtusely angulated in the middle, each having three or four rows of spines disposed exactly as in *P. punctatus* proper. Dorsal valve slightly concave, and ornamented as in the opposite one. Length 8, width 7 lines.

Professor M'Coy states, in his work on the Palæozoic fossils, that "this species is intermediate in all its characters between *P. punctata* and *P. fimbriata*, but is perfectly distinct from both as a species. It agrees with the former in the *numerous*, instead of single rows of spinules on each concentric band, while it differs from it, and agrees with *P. fimbriata* in the elongato-ovate form, absence of mesial furrow, and very great gibbosity of the ventral valve, differing, however, from it in the smaller size, greater number of concentric bands in a given space at the same distance from the beak, and in having several rows of minute punctures, instead of a *single* row of elongate tubercles on each band."

Both *P. punctatus* and *P. elegans* occur in many of the same localities. In England they are abundant in almost every locality where Carboniferous Brachiopoda have been found, such as in Derbyshire; abundantly also in the Craven district; near Bolland; in shale and limestone at Settle, in Yorkshire; in dark Carboniferous limestone at Lowick, Northumberland; at Kendal, Westmoreland; Poolwash and Ronaldsway, Isle of Man, &c. In Scotland it occurs abundantly in the Carboniferous limestone and shale of Lanarkshire, Renfrewshire, Ayrshire, Buteshire, Dumbartonshire, Stirlingshire, Haddingtonshire, and Fifeshire. In Ireland, in Calciferous slate and limestone at Lisnapaste, Millecent, Tankardstown, Bruckless, Cornacarrow, &c. On the Continent of Europe it is also common at Visé, Lives, Namur, &c., in Belgium; in the valley of Prikcha, at Kosatchi-Datchi, &c., in Russia. In America it abounds in several localities, such as Zanesville (Ohio), Eddyville (Kentucky), and in coal measures throughout the western states, &c.

PRODUCTUS KEYSERLINGIANUS, *De Kon.* Pl. XXXIV, figs. 15, 16.

PRODUCTUS ACULEATUS, *De Koninck.* Descrip. des Anim. foss. du Terrain Carb. de Belgique, pl. x, fig. 8 *a, b, c* (not Martin), 1843.

— KEYSERLINGIANUS, *De Koninck.* Mon. du genre Productus, pl. xiv, fig. 6 *a—d*, 1847.

— — — M'Coy, British Carb. Foss., p. 466, 1855.

Spec. Char. Shell small, subrectangular, or rotundato-quadrate; hinge-line slightly exceeding the average breadth of the shell. Ventral valve very gibbous, sometimes rather geniculated, and feebly depressed along the middle; beak small, and not overlying the hinge-line except at its attenuated extremity; ears small, slightly produced, and well defined. Surface traversed by numerous concentric lines of growth, as well as by a few wrinkles on the ears; a variable number of comparatively large spine-tubercles being likewise arranged somewhat in quincunx over the visceral portion of the valve. Dorsal valve

very slightly concave, traversed by small wrinkles and minute concentric lines of growth, a few elongated tubercule-pits being also irregularly scattered over the visceral portion of the valve. Length 5, breadth 6, greatest depth between the valves 2 lines.

Obs. As observed by Prof. de Koninck, this species is distinguished from *P. aculeatus* by its smaller dimensions, more transverse shape, slight median depression, and lesser concavity of its smaller valve. The spiny tubercules are not scattered over the entire surface of the ventral valve, as in Martin's species, but are restricted to the visceral portion of the valve. The interior is very similar to that of other *Producta*. *P. Keyserlingianus* is not a rare fossil in the Carboniferous limestone of Settle, in Yorkshire, but much less so in that of Derbyshire. I am not acquainted with any specimens from either Scotland or Ireland.

On the Continent it occurs at Visé, in Belgium, as well as at Likwin, Government of Kalouga, and of Cosatchi-Datchi, Ural.

PRODUCTUS SPINULOSUS, J. Sowerby. Pl. XXXIV, figs. 18—21.

PRODUCTUS SPINULOSUS, J. Sow. Min. Conch., pl. lxxviii, fig. 3, Oct., 1814.

PRODUCTA GRANULOSA, Phillips. Geol. of Yorks., pl. vii, fig. 15, 1836.

— *CANCRIINI, De Kon.* Desc. des Anim. foss. du Terrain Carb. de Belgique, pl. ix, fig. 3 (not of De Verneuil), 1843.

— *PAPILLATUS, De Kon.* Ib., pl. x, fig. 6.

— *GRANULOSUS, De Kon.* Mon. du genre Productus, pl. xvi, fig. 7, 1847.

— — *M'Coy.* British Palæozoic Fossils, p. 472, 1855.

— — *Dav.* Scottish Carb. Brach., pl. iv, figs. 22—24, 1861.

Spec. Char. Shell transversely semicircular; hinge-line a little shorter than the greatest width of the shell. Ventral valve regularly convex and evenly arched, without sinus; beak incurved, but not overlying the hinge-line, except at its attenuated extremity; ears flattened, with a few concentric wrinkles; surface covered with sub-regular, small, slightly elongated tubercules, irregularly or quincuncially arranged, each tubercule producing a slender spine. The tubercules are more often about half a line or so apart near the middle of the shell, but closer as they approach the beak. Dorsal valve deeply and evenly concave, and covered with small tubercule-pits, arranged somewhat in quincunx. Interior unknown. Length 7, width 9 lines.

Obs. This species does not appear to have attained proportions very much larger than those above recorded, and is easily distinguished from all other British *Producta* by shape and sculpture. To those examples in which the tubercules or spines were regularly arranged in quincunx the term *spinulosus* has been applied, while to those in which the spines or tubercules were less regularly disposed the term *granulosus* was given. I quite coincide, however, in the opinion expressed by Prof. M'Coy, that the two are simply different conditions of the same species, and should be therefore united. Prof. M'Coy is also of opinion that *P. Koninckianus*, De Verneuil, is distinct, and it is probable that *P. spinu-*

losus, De Koninck (but not of Sow.), is likewise a different species, for in addition to the tubercules, the shell is represented as being finely longitudinally striated, a character never observable in the many British examples of *P. spinulosus*, Sow., and *P. granulosus*, Phillips, that have come under my observation. I have never yet seen a well-preserved exterior of the smaller valve, but believe it to have possessed spines. In England *P. spinulosus* occurs in the Carboniferous limestone of Bolland; Settle, in Yorkshire; the Isle of Man, and in several Derbyshire localities. In Scotland it has been collected at Nellfield and Hillhead at 375 fathoms below "Ell Coal;" occurs likewise at Brockley, near Lesmahago, in Lanarkshire. In Ayrshire, at West Broadstone and Auchenskeigh, near Dalry. At Cat-Craig, near Dunbar, &c. In Ireland Mr. Kelly mentions Knockinny, Killukin, Millicent, and I possess a specimen from Little Island, near Cork, for which I am indebted to Mr. J. Wright. On the Continent it occurs at Visé, in Belgium, and has been found in Russia.

PRODUCTUS PLICATILIS, *J. Sow.* Pl. XXXI, figs. 3—5.

PRODUCTUS PLICATILIS, *J. Sowerby.* Min. Conch., pl. 459, fig. 2, July, 1823.

— — — *Phillips.* Geol. of York., vol. ii, pl. viii, fig. 4, 1836.

LEPTENA POLYMORPHA, *Muenster.* Verzeichniss der in der Kreis-Natur. Samml. zu Bayr. befindl. Petref., p. 45, 1840 (according to Prof. de Koninck).

PRODUCTUS PLICATILIS, *De Kon.* Desc. des Anim. foss. du Terr. Carb. de Belgique, pl. xii, fig. 7, 1843; and Monographie du genre Productus, pl. v, fig. 6, 1836.

— — — *M'Coy.* British Pal. Foss., p. 168, 1855.

Spec. Char. Shell thin, transversely oblong, slightly indented in front; hinge-line about as long as the greatest width of the shell; ventral valve gibbous, and more or less geniculated; the visceral disc is semicircular and very slightly convex, while the anterior prolongation is abruptly arched; a median depression or sinus commences likewise at a short distance from the beak and extends to the front. Beak small, not overlying the hinge-line; ears flattened. Exteriorly, the visceral disc or posterior half of the valve is traversed by numerous regular or irregular, undulating, concentric wrinkles, while the entire surface is covered with fine, thread-like, longitudinal striæ. Spines long, slender, few in number, and rising here and there from the surface of the valve. Dorsal valve concave, with a small mesial elevation or fold towards the front. Sculpture similar to that of the opposite valve. Dimensions variable; two examples have measured—

Length 16, width 23, greatest depth between valves 7 lines.

„ 10, „ 13, „ „ 4 „

Obs. This Productus is well distinguished from its congeners both by shape and sculpture. It bears some slight resemblance to *Strophomena analoga*, but (as justly observed by Profrs. de Koninck and M'Coy) does not possess the area of the last-named species, and its interior details are those of *Productus*, as may be seen by a glance at fig. 5

of our plate, which represents an internal cast of the ventral valve, on which the adductor and divaricator impressions are well marked. The interior of the dorsal valve does not appear to have been hitherto discovered, at least no example has come under my observation. From *P. sub-lævis* the form under description is distinguished by its transverse shape and much smaller dimensions, &c.

In England it is found in the Carboniferous limestone of Settle, in Yorkshire; the gray or lower limestone of Longnor and Castleton, in Derbyshire. In Ireland Mr. Kelly mentions that it occurs in the limestone of Armagh, Salmon, and Little Island. No specimen from Scotland has been hitherto produced, but it is very common in the limestone of Visé, in Belgium, as well as in the dark limestone of Hof, in Bavaria, and Falkenberg, in Silesia. It has also been stated to occur in Russia, but was not met with there by the authors of the 'Travels in Russia and Ural.'

PRODUCTUS SUB-LEVIS, *De Koninck*. Pl. XXXI, figs. 1, 2; Pl. XXXII, fig. 1; and Pl. LI, figs. 1, 2.

PRODUCTUS SUB-LEVIS, *De Koninck*. Descript. des Anim. foss. du Terr. Carb. de Belgique, pl. x, fig. 1, 1843.

STROPHOMENA ANTIQUATA, *Potiez et Mich.* Galer. des Moll. de Douai, vol. ii, pl. xlii, fig. 5, 1844 (according to De Koninck).

PRODUCTUS SUB-LEVIS, *De Keyserling*. Reise in das Petschora Land, pl. v, figs. 3 and 3^a, 1846.

— CHRISTIANI, *De Koninck*. Monographie du genre Productus, pl. xvii, fig. 3, 1847.

Spec. Char. Shell elongated oval, sub-quadrangular, and longer than wide; hinge-line about as long as the greatest width of the shell. Ventral valve gibbous, much vaulted upon itself at the beak, and longitudinally divided by a median groove or ridge, which commences to appear at a short distance from the beak, and extends to the front, while the lateral portions of the valve are more or less deeply furrowed; ears moderately developed, sub-cylindrically coiled, and sharply defined from the body of the shell by a row of tubular spines. Externally the visceral portion of the valve is traversed by numerous concentric, feebly marked wrinkles, while the entire surface is longitudinally and finely striated. Dorsal valve concave, following the curves of the opposite valve, and similarly sculptured. Interior unknown. Dimensions variable; two British examples have measured—

Length 4 inches 8 lines, width 4 inches 1 line.

„ 3 „ 9 „ „ 3 „ 10 „

Obs. This remarkable Productus varies much in appearance, according to age and specimen. When the external coat or surface is well preserved, it is very finely striated, as well as crossed by many concentric lines of growth, but when the outer surface has been removed by fossilisation the shell appears to be almost entirely smooth. Some examples

are likewise more deeply longitudinally grooved than are others, while in the ventral valve of certain examples there exists a median depression, which in others is converted into a projecting ridge.

It has appeared to me, after the attentive examination of about a dozen specimens, that Prof. de Koninck's *P. sub-lævis* and *P. Christiani* are only different conditions of a same and single species, and should therefore be united. In England *P. sub-lævis* occurs in the Carboniferous limestone of Clitheroe, in Lancashire, where it has been several times obtained by Mr. J. Parker, Curator of the Manchester Museum. It has also been stated to have been found in Wales, but no other British locality than that above given has been correctly ascertained. On the Continent it has been found by M. de Koninck in the Carboniferous limestone of Visé, in Belgium, and of Glageon, near Avesnes, in France, and appears to have sometimes attained rather large dimensions, although nowhere hitherto found in any profusion.

PRODUCTUS MESOLOBUS, *Phillips*. Pl. XXXI, figs. 6—9.

PRODUCTA MESOLOBA, *Phillips*. Geol. of Yorks., vol. ii, pl. vii, figs. 12, 13, 1836.

PRODUCTUS MESOLOBUS, *De Kon.* Desc. des Anim. foss. du Terr. Carb. de Belgique, pl. xii, fig. 8, 1843; and Monographie du genre Productus, pl. xvii, fig. 2, 1847.

— — *De Verneuil.* Russia and the Ural Mount., vol. ii, pl. xvi, fig. 8, 1845.

— — *M'Coy.* British Pal. Fossils, p. 468, 1855.

— — *Dav.* Mon. of Scottish Carb. Brach., pl. xxi, 1861.

Spec. Char. Shell thin, transversely oblong, and generally rather wider than long; hinge-line as long, and sometimes longer, than the average width of the shell; ears or cardinal extremities wide, and at times much extended. Ventral valve gibbous at the beak, and somewhat geniculated towards the front, with a wide, flattened, or slightly concave sinus, interrupted in the middle by a narrow median rib, and on either side of the sinus a rib is present, while another intervenes between these and the cardinal angles. The beak is proportionately large, and not overlying the hinge-line, except quite at its attenuated extremity. Exteriorly the visceral disc is covered with numerous concentric wrinkles, and a few tubular spines project from the five ribs. Dorsal valve concave, with a narrow median groove and two slightly marked lateral ones, while the surface is covered with concentric wrinkles and lines of growth. Interior unknown. Dimensions variable; three British examples have measured—

Length 11, width 19 lines.

„ 9, „ 12 „

„ 15, „ 14 „

Obs. Some foreign specimens have exceeded the proportions here given, and although

possessing some of the characters of both *P. plicatilis* and *P. sub-lævis*, can always be distinguished by its narrow median ridge, deeper sinus, and lateral ribs.

In England it is found in the Carboniferous limestone of Settle, in Yorkshire, the dark limestone of Kendal, Poolwash, Isle of Man, as well as in the gray limestone of Derbyshire. In Scotland it has been found at 375 fathoms below "Ell Coal." At Braidwood, in Lanarkshire, also at Brockley, near Lesmahago; in Stirlingshire, in the Glarat lime works, or Campsie main limestone. In Ireland at Cornacarrow, Millecent, Little Island. On the Continent it occurs in the limestone of Visé and Tournay, in Belgium. In Russia, at Ilinsk, on the Tchusovaya, Ural Mountains.

Sub-genus—CHONETES, *Fischer*.¹

We have already alluded to the close relationship which exists between *Chonetes* and *Productus*, and must now refer to the great difficulties in the way of a correct and definite determination of its species, which appears to have been unnecessarily multiplied, and at times been fabricated out of undeterminable or uncharacterised specimens or fragments. The confusion in which I found the species was so great that all my many efforts, consultations, and researches, have proved ineffectual to satisfactorily solve the difficulty with reference to some few of Prof. M'Coy's Irish so-termed species; but in order that the reader may form his own opinion, or be better enabled to continue the research, I have given figures of all the uncertain species (?), and, when desirable, reproduced the original descriptions. I have not been able to determine satisfactorily more than five or six species, viz.—1. *Chonetes comoides*; 2. *C. papilionacea*; 3. *P. Dalmaniana*; 4. *C. Hardrensis*; 5. *C. Buchiana*; and 6. *C. polita*. Those termed *C. laquessiana*, De Kon., *C. papyracea*, *C. crassistria*, *C. tuberculata*, *C. sub-minima*, *C. gibberula*, *C. sulcata*, *C. volva*, *C. perlata*, and *C. serrata*, M'Coy, may still demand further research, although I have myself but little doubt that the whole number are merely different conditions or synonyms of some of the five or six species above recorded; and even out of this number I do not feel entirely confident with reference to *C. Dalmaniana*. In his monograph of the sub-genus *Chonetes*, Prof. de Koninck states that "the slight difference which exists between the form and the exterior sculpture of the various species renders their classification much more difficult than that of *Productus*, and that he has taken as basis for his arrangement the number and

¹ Prof. M'Coy considers *Chonetes* to be simply a sub-genus of *Leptæna*, removing it, as well as *Strophalosia* (King) and *Aulosteges* (Helmersen), from the family PRODUCTIDÆ ('British Pal. Foss., Cambridge Museum,' p. 211), and placing them as a sub-genus among his *Orthisidæ*; but this view appears to me far from correct, as I have endeavoured to demonstrate in p. 112 of my 'General Introduction,' when showing that the reniform impressions are the same in *Chonetes* as in *Productus*, while a completely different arrangement prevails among the *Strophomenidæ*, of which *Leptæna* constitutes only a section.

nature of the longitudinal ribs which ornament the surface of all the species, with the exception of a single one, wherein these are replaced by concentric plaits." In Great Britain this last-named shell has not been hitherto discovered, but another, which is entirely smooth, has been obtained, so that the British species can be divided into two groups, which we will distinguish as follows, and to which we have added the probable synonyms.

STRIATE.	{	<i>C. comoides</i> , Sowerby.
		<i>C. papilionacea</i> , Phillips = <i>C. multidentata</i> , M'Coy = <i>C. papyracea</i> , M'Coy?
		? <i>C. Dalmaniana</i> , De Koninck.
		<i>C. Hardrensis</i> , Phillips = <i>C. sub-minima</i> = <i>C. gibberula</i> = <i>C. sulcata</i> ? = <i>C. volva</i> ? = <i>C. perlata</i> ? M'Coy = <i>C. laguessiana</i> ? De Koninck.
		<i>C. Buchiana</i> , De Koninck = <i>C. crassistria</i> , M'Coy.
LEEVES.		<i>C. polita</i> , M'Coy.
Uncertain species?		<i>C. tuberculata</i> and <i>C. serrata</i> , M'Coy.

Although my distinguished friend has considered the arrangement, the number, and nature of the longitudinal striæ as the best means or character to be used in the discrimination of the species, I have not always found them sufficient, on account of the extraordinary variability in this particular which almost every specimen has presented not only at different stages of growth, but in shells of similar dimensions, and I believe that we will find the interior details in each of the species to be somewhat different, and a character of greater importance even than that of the exterior, as may be noticed in those of which we have been so fortunate as to procure specimens; and, indeed, in so difficult a matter every point, both exterior and interior, will require to be carefully examined and compared before a correct determination can be arrived at, and surely the difficulty will be great indeed, and even insurmountable, in those cases where the so-termed species have been fabricated from a crushed or imperfect fragment of a single valve!

CHONETES COMOIDES. Pl. XLV, fig. 7 (1 to 6?).

PRODUCTUS COMOIDES, <i>J. Sow.</i> Min. Conch., pl. 329, April, 1816.	
CHONETES	— <i>De Keyserling.</i> Reise in das Petschora-land, pl. vi, fig. 1, 1846.
—	— <i>De Koninck.</i> Monographie du genre Chonetes, pl. xix, fig. 1, 1847.
—	— <i>Dav.</i> Quarterly Journal of the Geol. Soc., vol. x, pl. viii, fig. 1, and 2—8? 1853.

Spec. Char. Shell large, transversely semicircular, concavo-convex; hinge line straight, as long or a little shorter than the greatest width of the shell; valves strongly articulated by the means of teeth and sockets. Ventral valve convex, beak more or less developed and incurved, but not overlying the cardinal edge. Dorsal valve concave, following the curves of the other. Each valve is provided with a subparallel area of greater or lesser width, but

always narrower in the smaller valve. In the middle of this last there exists a produced, trilobed, cardinal process, which enters and almost fills a corresponding triangular fissure in the ventral area, and which was probably partly covered or arched over by a pseudo-deltidium. The external surface of the shell is finely striated. In the interior of the greatly thickened ventral valve, and under the extremity of the beak, at the base of the fissure between the projecting teeth, originates a large, deep, pyriform muscular cavity, extending to beyond half the length of the valve, and occupying upwards of a third of its inner surface, its greatest breadth being towards the centre of the shell. In this depression are situated four elongated muscular impressions, and these are separated to a greater or lesser extent by three longitudinal ridges, the central one of which is shorter than the others, and assumes the character of a mesial septum; the two smaller scars, situated on either side near the central ridge, are due to the adductor, the outer and larger ones to the cardinal or divaricator muscles, the muscular scars not being equally deep in every example. Of the interior of the dorsal valve nothing is at present known. Dimensions variable; two British specimens have measured—

Length 2 inches $7\frac{1}{2}$ lines, width 3 inches 10 lines.

„ 3 „ 5 „ „ 6 „ 2 „

Obs. Sowerby's specimens of this remarkable species are incomplete, and his descriptions and illustrations consequently so, but he did not fail to mention that the shell is "very thick and rough within," this allusion having reference to the ventral valve only, for, as I have elsewhere shown, the convex valve was often four or five times as thick as the concave or dorsal one. Sowerby's figures do not show the fissure which exists in the area of the ventral valve, nor do they exhibit the area of the dorsal one, which is so well displayed in a specimen preserved in the Bristol Institution Museum (Pl. XLV, fig. 7). No spines could be detected on any of the few examples that have come under my observation, although some small circular holes could be perceived here and there, close to the cardinal edge, in one of the specimens; but it must likewise be remembered that the cardinal spines were very small in some other species of *Chonetes*, and especially so in the large *C. papilionacea*, and may, consequently, not have existed, or been destroyed, on the few fossil examples we possess.

It has been questioned whether the shell under description should be located with *Chonetes* or with *Productus*, and that we are not acquainted with the interior of the smaller and most important valve; still the area in both, and the strongly articulated hinge, would be an anomaly in *Productus*, which, on the contrary, is the constant character of *Chonetes*, and this alone would, at least provisionally, induce me to leave *C. ? comoides* in the last-named sub-genus. It has also been doubted whether the shells, fig. 1—6 of my Pl. XLV, do really belong to Sowerby's species; and here, again, I must repeat what I said in 1853, viz., "that I do not feel convinced that sufficient grounds exist for the establishing of two distinct species (an opinion in which I was then supported by Messrs. Salter and Woodward), the original type not appearing to us to differ materially in its

convexity from several of those represented in my plate." The area, I am ready to admit, is certainly wider in both Mr. Sowerby's specimens than in those belonging to Mr. Ormerod (figs. 1—6), but the area generally varies much in its width in specimens of a same species, as I have already often had occasion to notice. Mr. Sowerby's second example (not figured in the 'Min. Conch.') is an incomplete interior of the *ventral valve*, in which, from the shell being young and shallow, the muscular impressions could not be as deep or as indented as in adult, very convex and thickened valves, such as is the original specimen figured in the 'Mineral Conchology,' or those illustrated in my plate (figs. 3, 4); nor could I perceive that the interior of Sowerby's specimen varied in any *essential* particular from those more perfect examples I had examined. In any case, fig. 7 must be regarded as the typical shape of *C. comoides*, of which the other specimens figured by me are probably variations.

Chonetes comoides does not appear to be a very common species, and all the specimens hitherto procured are from the Carboniferous limestone. It has been found in England and in Ireland in the following localities:—Llangaveni and Beaumaris, in Anglesea; Llanymynech and Tidenham Chase, in Gloucestershire; Chepstow, Treflach Wood, south-west of Oswestry; Bundoran, County Donegal; and Lough Erne, Fermanagh. On the Continent it appears to be equally rare; Prof. de Koninck mentions having found a single specimen at Visé, in Belgium, and that he possesses another example from Sablé, in France; that Count Keyserling has found it in the Carboniferous limestone at the banks of the River Ylytsch, in the Ural, and that the Museum of St. Petersburg possesses examples from the neighbourhood of Switschei, a village on the banks of the Ugra, in the Government of Kaluga, in Russia.

CHONETES PAPILIONACEA, *Phillips*. Pl. XLVI, figs. 3—6.

PECTINITES FLABELLIFORMIS, *Lister*. Hist. Conch., lib., iii, pl. 475, fig. 31, 1688.

SPIRIFERA PAPILIONACEA, *Phillips*. Geol. of York., vol. ii, pl. ii, fig. 6, 1836.

CHONETES PAPILIONACEA, *De Koninck*. Description des Anim. foss. du Terr. Carb. de Belgique, pl. xiii, fig. 5, and pl. xiii^{bis}, fig. 1, 1843; and Monog. du genre Chonetes, pl. xix, fig. 2, 1847.

— MULTIDENTATA, *M'Coy*. Synopsis of the Char. of the Carb. Fossils of Ireland, pl. xx, fig. 8, 1844.

— PAPYRACEA, *M'Coy*? Ibid., pl. xx, fig. 2.

Spec. Char. Shell thin, sometimes rather large, transversely semicircular, depressed, slightly concavo-convex, but almost flat when young. Hinge-line straight, and as long as the width of the shell. Ventral valve slightly convex at the beak, but much flattened at the sides, and especially so near the cardinal edge; beak small, and not protruding beyond the cardinal edge; dorsal valve very gently concave along the middle, lateral portions much flattened; a well-defined area is present in each valve, the ventral one, which is the widest, being divided in the middle by a triangular fissure, partially arched over by

a pseudo-deltidium, the cardinal process of the opposite valve filling up the remaining open space. Surface of both valves covered with numerous fine, thread-like, straight or flexuous striæ, which become more numerous by means of bifurcation and interstriation at variable distances from the beak and umbo, the striæ and interspaces being closely crossed by numerous fine, concentric lines of growth, which produce a beautifully crenulated appearance. Small spines rise from the striæ at variable distances, and a row of from twenty to thirty short ones project from the cardinal edge. Valves strongly articulated by means of teeth and sockets. Interior details imperfectly known. Dimensions variable; two British examples have measured—

Length 2 inches, breadth 5 inches 3 lines, greatest width between the valves 3 lines.

„ 1 „ „ 1 „ 9 „ „ 1½ „

Obs. This is perhaps the largest and most beautiful species of the sub-genus hitherto discovered, and is remarkable on account of its elegant shape and sculpture. *C. comoides* is the only species with which the shell under description might be compared, but from which it can be distinguished without much difficulty, *C. comoides* being a much more ponderous and gibbous shell, and whose beak appears to be generally more rounded and produced than is that of *C. papilionacea*. Although it received the very appropriate name of *papilionacea* from Phillips in 1836, it had been figured and shortly described by Lister in 1688 — “*Pectinites flabelliformis tuberculoso commissura seu pectinites semicircularis compresso minuta ad modum striatus.*”

C. multidentata, McCoy, of which I have been able to examine the original specimen, is evidently a synonym of the shell under description, and I am inclined to believe that the fragment figured and described by the same author under the denomination of *C. papyracea* is also another synonym. In England *C. papilionacea* has been found in the Carboniferous limestone of Bolland, Otterburn, Kendal, Settle, Ronalds Way, Isle of Man, and Dalton, in Furness, Lancashire, &c. In Ireland at St. John's Point, Ballybodonnell, Dunkineely; Cheeverstown, County Dublin, &c. On the Continent it has been found by Prof. de Koninck in the Carboniferous limestone of Visé, Chokier, and Temploux, in Belgium; Karova, Government of Kalougarear, Moscou; and at Sablé, in France.

CHONETES DALMANIANA, *De Koninck*. Pl. XLVI, fig. 7.

CHONETES DALMANIANA, *De Kon.* Desc. des Animaux foss. du Terrain Carb. de Belgique, pl. xiii, fig. 3; pl. xiii bis, fig. 2, 1843; and Mon. du genre Chonetes, pl. xix, fig. 3, 1847.

Spec. Char. Shell thin, transversely semicircular, concavo-convex; hinge-line as wide as the greatest breadth of the shell. Ventral valve regularly, but moderately, convex; area narrow, sub-parallel, and divided in the middle by a small fissure, partly arched over by a pseudo-deltidium. Dorsal valve concave, following the curves of the opposite one; area

narrow; surface of both valves covered with numerous fine, radiating striae, which become more numerous as they proceed from the beak and umbo to the margin from bifurcation and interstriation. Spines few on the surface of the ventral valve, but a row of longer ones rise from and follow close to the cardinal edge. Interior unknown. Dimensions variable; a British example measured—length 8, breadth 14 lines.

Obs. I am but very imperfectly acquainted with this species. Certain fragmentary specimens from the lower Scar limestone of Settle, in Yorkshire, could not be distinguished from some small Belgian examples of *C. Dalmaniana* I had received from Prof. de Koninck, and for which reason the species (?) is, with some uncertainty, here provisionally introduced. The specimens I have been able to examine of the shell under description appear to me intermediate in shape and character between *C. papilionacea* and *C. Hardrensis*. Prof. de Koninck mentions that it can be distinguished from the young age of *C. papilionacea* by its greater curvity (or convexity) and longer cardinal spines; it appears, also, to attain larger dimensions than *C. Hardrensis*, which some examples very closely resemble. Prof. de Koninck has given as synonyms of his species *Leptæna* (*Chonetes*) *volva* and *L.* (*Chonetes*) *multidentata* of M'Coy, but I cannot coincide with this determination, for, as already stated, *C. multidentata*, M'Coy, evidently belongs to *C. papilionacea*, and I am almost disposed to look upon *C. volva* as a variety of *C. Hardrensis*?

CHONETES BUCHIANA, *De Koninck*. Pl. XLVII, figs. 1—7, and 28.

CHONETES BUCHIANA, *De Kon.* Descrip. des Anim. foss. du Terr. Carb. de Belgique, pl. xiii, fig. 1, 1843.

— — *Dav.* A Monograph of Scottish Carb. Brachiopoda, pl. ii, fig. 1, 1861.

LEPTÆNA CRASSISTRIA, *M'Coy*. Synopsis of the Carb. Foss. of Ireland, tab. xx, fig. 10, 1844; and British Carb. Foss., pl. iii n, fig. 5, 1855.

Spec. Char. Shell marginally transversely semicircular, concavo-convex, about one third wider than long; hinge-line straight, and either a little shorter, with its cardinal angles rounded, or exceeding the width of the shell, with rectangular or slightly acute and extended terminations. Both valves are provided with narrow sub-parallel areas; the ventral one, which is the largest, being divided by a small fissure, partially covered with a pseudo-deltidium, while in the middle of the ventral one there exists a prominent, V-shaped cardinal process. The ventral valve is moderately convex, and flattened towards its auriculate cardinal extremities. The beak, which is small and incurved, does not overlie the hinge-line. Dorsal valve concave, following the curves of the opposite one. Exteriorly the surface of the ventral valve is ornamented with from twelve to thirty generally simple ribs, with wider or narrower interspaces, the lateral ribs being sometimes larger than those which occupy the middle of the shell; the dorsal valve is similarly ornamented. Spines

short and not very numerous, on the surface of the valve, but a row rises and follows close to the cardinal edge. In the interior of the ventral valve there exists a tooth on each side of the fissure; the adductor muscular impressions are small, but prominent, and separated by a median ridge or septum, which extends to about one third of the length of the valve. Immediately under and outside of the adductor scars are two concave, sub-quadrangle, longitudinally grooved impressions, attributable to the cardinal or divaricator muscles. In the interior of the dorsal valve, under the cardinal process, exists a mesial ridge or plate, which extends to nearly two thirds of the length of the valve, and on either side may be seen two well-defined muscular scars, which are produced by the quadruple attachment of the adductor or oclusor muscle, while outside and in front of these are situated the reniform impressions. The remaining surface not occupied by muscular impressions is in both valves covered with small asperities. Dimensions very variable; three British examples have measured—

Length 8, width 11, greatest depth between valves $1\frac{1}{2}$ lines

„ 6, „ 9, „ „ 1 „

„ 7, „ 13, „ „ 2 „

Obs. This species is, in general, easily distinguished from its congeners by its strong, simple ribs; but although these are simple in the greater number of specimens, I have noticed a tendency in a few rare instances to bifurcation and even interstriation close to the margin, and especially so in one example from the gray Carboniferous limestone near Settle (fig. 7), and which I had at one time distinguished by the varietal designation of *interstriata*. The ribs are exceedingly variable in their number and strength in different specimens, and every number between twelve and thirty can be counted in different examples, so that the gradation is complete. It is highly probable, if not certain, that Prof. M'Coy's *C. crassistria* is nothing more than a variety of *C. Buchiana* with small ribs, and, indeed, closely agrees with some Belgian examples of this last I received from Prof. L. de Koninck.

In England the species under description occurs in the Carboniferous limestone of Settle, and again in shales at Malham Moor, in Yorkshire, the specimens in the limestone possessing, in general, a greater number and smaller ribs than in the variety which is met with in the shales. It has been found also at Rutchough, in Northumberland. In Scotland it occurs at Gare, in Lanarkshire, at 239 fathoms below “Ell Coal,” and in black Carboniferous shales (*calp*) at Bundoran, in Ireland. On the Continent it was first discovered by Prof. de Koninck in the lower Carboniferous limestone of Visé, in Belgium, where it is very rare.

CHONETES HARDRENSIS, *Phillips*. Pl. XLVII, figs. 12—16, 17, 18, and 25?

PECTEN - - - - *Ure*. Hist. of Rutherglen and East Kilbride, p. 317, pl. xvi, figs. 10, 11, 1793.

CHONETES HARDRENSIS, *Phillips*. Figures and Descriptions of the Palæozoic Fossils of Cornwall and West Somerset, p. 138, pl. lx, fig. 104, 1841.

LEPTÆNA (CHONETES) HARDRENSIS, *McCoy*. British Pal. Foss., 454, 1855.

CHONETES HARDRENSIS, *Dav.* Mon. of Scottish Carb. Brach., pl. ii, fig. 2, 1861.

Spec. Char. Shell marginally semicircular, wider than long, concavo-convex; hinge-line straight, and either a little shorter or somewhat longer than the width of the shell, with rounded or angular terminations; each valve is provided with a sub-parallel area, but which is widest in the ventral one, and divided in the middle by a small fissure, partially covered by a pseudo-deltidium; ventral valve moderately convex, sometimes slightly depressed along the middle and flattened towards its auriculate cardinal extremities; the beak, which is small and incurved, does not overlie the hinge-line, while the dorsal valve assumes in different specimens a greater or lesser degree of concavity, with, at times, a slight longitudinal elevation along the middle, and flatness near the cardinal extremities. The surface of both valves is covered with numerous thread-like, radiating, and often bifurcating striæ, which increase in number by the interpolation of striæ at various distances from the beak and umbo, so that as many as 120 striæ may in some examples be counted round the margin, while at irregular distances small spines rise from their rounded surface in addition to those on each side of the beak; in adult examples there exist along the cardinal edge from five to nine slanting, tubular spines, which become longer and larger as they approach the extremities of the cardinal edge. The valves are articulated by means of teeth and sockets, while the muscular and other impressions do not differ materially from those already described in the preceding species. Dimensions variable; an average-sized specimen has measured—length 7, width 11, greatest depth $1\frac{1}{2}$ lines.

Obs. The determination of the present species has given me much trouble; and although I have spent much time in the endeavour to arrive at a satisfactory conclusion, it is not without some hesitation that the term *Hardrensis* is here provisionally retained; provisionally, because I am as yet unable to determine whether Phillips's Devonian shell is the same as that to which Schlotheim, in 1820, applied the denomination *sarcinulata*, as Prof. de Koninck's illustrations of this last differ so much from those given by Prof. Schnur and some other palæontologists. I am likewise uncertain whether J. de C. Sowerby's *Lept. sordida* (1840) be really a synonym of the last-named shell, or different from Phillips's *Hardrensis*, as has been stated to have been the case by some authors; and lastly, because my learned friend, Prof. de Koninck, who has paid so much

attention to the species of the genus, maintains a different opinion to that here recorded, while not absolutely denying the possibility of mine being correct.

Geologists and palæontologists have for many years been in the habit of distinguishing the Chonetes we are at present describing by the name *Hardrensis*, and although Prof. de Koninck, in page 206 of his 'Monographie du genre Chonetes,' has referred this shell and the one figured by Ure in 1793 to *C. variolata*, he subsequently determined that our form could not be assimilated to D'Orbigny's species, and proposed that the Scottish shell, which occurs also at Visé, in Belgium, should be made a new species of under the designation of *C. alternata*.¹ Having received from Prof. Phillips the loan of his four best and figured examples of *C. Hardrensis*, and having compared these with our Scottish and other examples, the result was that I could perceive no difference in the shape, areas, and striation, so that I deemed it preferable to allow the *Chonetes* we are describing to retain the name *Hardrensis*. *C. Hardrensis* is certainly a very variable species, and this has, no doubt, induced palæontologists to consider some of its variations in shape to be distinct species. The striæ vary much in number and strength. In some specimens they are exceedingly numerous and fine, while in other examples they are less numerous and coarser, the shell differing also much according to age and locality. *C. Hardrensis* (as I understand it) occurs in the limestone and shales of many English, Scottish, and Irish localities. In England it is found at Settle, in Yorkshire; Sturaway, in Shropshire, Newton-on-the-More, Northumberland, &c. In Scotland it is met with at Gare, in Lanarkshire, at 239 fathoms below "Ell Coal," 343 at Raes Gill, 356 at Hill-head. It occurs also at Capelrig, East Kilbride, Auchentibber and Calderside, High Blantyre; Brockley, near Middleholm, Lesmahago; Robroyston, north of Glasgow. In Renfrewshire at Arden Quarry and Orchard Quarries, Thornliebank. In Stirlingshire in various stages, such as Craigenglen, Mill Burn, the Campsie main limestone, Corrieburn, &c. In Ayrshire at West Broadstone, Beith; Auchenskeigh, Dalry; Goldcraig, Kilwinning, &c. In Ireland it occurs in many localities in the counties of Dublin and Kildare, &c.

In the shale above the "Hosie limestone" at South Hill, Campsie, in Stirlingshire, we find millions of specimens of a small variety (?) of the shell under description (fig. 22), but it does not appear to have exceeded some two and a half lines in length by three in width, the generality of specimens being even smaller. Mr. Young, to whom we are indebted for

¹ Having been enabled to compare a great many specimens of *C. variolata*, D'Orb., = *C. granulifera*, Owen, with our Carboniferous *C. Hardrensis*, I could perceive little or no difference between many of the specimens, although the ribs are at times, perhaps, finer and more numerous in certain examples of the American *C. variolata* than in some specimens of Phillips's species, so that I do not consider Prof. de Koninck to have been much mistaken when he referred Ure's figures to D'Orbigny's species. I may likewise observe that the interior details are in both exactly similar. *Chonetes striatella*, Dalman, sp., from the Silurian limestone of Gotland, closely resembles some examples of *C. Hardrensis*; it is, however, a little more concavo-convex, and I could not trace the existence of spines on its surface.

the knowledge we possess relative to this shell, thought it might be, perhaps, different from *C. Hardrensis*, but I am inclined to look upon it as a simple local variation or smaller race of the last-named species. In the shales of Newton-on-the-More and Derwick, as well as in those of Rahoran, in Ireland, we find another variety, with very fine striæ, which Prof. de Koninck has identified as his *Chonetes laquessiana* (fig. 19 of my plate), 'Monographie du Genre Chonetes,' p. 191, pl. xx, fig. 6; but after a very careful examination of many specimens, I could not bring myself to consider it specifically distinct from *C. Hardrensis*. Several of Prof. M'Coy's so-termed species appear to me to be variations or synonyms of the shell under description, but as palæontologists may perhaps object to the view I have taken, it will be preferable as well as desirable to allude to them under separate heads.

A.—*Chonetes (Leptaena) gibberula*, M'Coy. Synopsis of the Characters of the Carb. Foss. of Ireland, pl. xx, fig. 11, 1843 (23 of my plate).

"Semicircular, length two thirds the width, very gibbous in the middle; ears acute, flattened; surface very finely and regularly striated longitudinally; length one and a half lines, width three lines.

Loc. "Calcareous slate of Lisnapaste, Ireland." M'Coy.

B.—*Chonetes (Leptaena) subminima*, M'Coy. British Pal. Fossils, p. 456. Pl. iii, fig. 31, 1855 (fig. 24 of my plate).

"Rotundato-quadrate; length three fourths or four fifths of the width; receiving (ventral) valve very gibbous in the middle; greatest depth a little behind the middle; hinge-line as long as the shell is wide, forming flattened ears, slightly acute from the sigmoid outline of the sides, having three or four moderately long, slender spines on each side of the beak, extending backwards, as usual, in the plane of the margin; front margin moderately convex. Surface uniformly covered with close, obtuse striæ, once or twice branched, but nearly uniform in size on all parts of the shell, and so fine that twelve at the margin only occupy half a line when decorticated, the impressed lines between the striæ of the surface being coarsely punctured, and the beak slit by very deep impressions of the mesial septum, extending half the length of the shell. Entering (dorsal) valve nearly as concave as the receiving one is convex; surface similar in both valves, the striæ being crossed by fine, close lines of growth. Average width one and a half line, the depth seems about half the width. Very abundant in a piece of the black upper Carboniferous limestone of Derbyshire." (M'Coy, p. 456.)

Obs. These two so-termed species appear to me to be nothing more than young shells of *C. Hardrensis*, and Prof. de Koninck has placed the first among the synonyms of *C. sulcata*, which I am likewise inclined to look upon as a synonym of *C. Hardrensis*. I

think, however, that my Belgian friend is not quite correct while uniting *Chonetes crassistria* to *C. gibberula* and *sulcata*, for reasons already stated.

c.—*Chonetes (Orthis) sulcata*, M'Coy. Synopsis of the Characters of the Carb. Foss. of Ireland, pl. xx, fig. 6 (fig. 20 of my plate).

"Semicircular, gibbous; ears flattened; surface with very coarse, rounded, frequently branched striæ; hinge-line exceeding the width of the shell, furnished with ten strong, conical spines." (M'Coy, p. 126.)

Loc. Arenaceous shale, Bruckless, Dunkineely.

Having had the advantage of being able to examine the original specimen in Sir R. Griffith's collection, I could not distinguish it from many specimens of *C. Hardrensis*. The figure in the 'Synopsis' is not quite correctly drawn; that in my plate was taken from the type.

d.—*Chonetes (Leptaena) volva*, M'Coy. Synopsis of the Characters of the Carb. Foss. of Ireland, pl. xviii, fig. 14 (fig. 21 of my plate).

"Semicircular, gibbous; ears involute, separated from the body of the shell by a shallow depression; hinge-line twice the length of the shell; furnished with twenty-four slender, hooked spines; surface covered with fine, flexuous striæ. Length eight lines, width one inch four lines." (M'Coy, p. 121.)

Loc. Lower limestone, Millecent, Clare, &c.

Obs. Through the kindness of Sir R. Griffith I have been enabled to examine the type and several other examples of this so-termed species, and I must confess that, although I am not quite prepared to positively assert that *C. volva* is a synonym of *C. Hardrensis*, I must observe that many of the specimens could not be distinguished from the last-named shell. The striæ are not simple, but arranged exactly as in *C. Hardrensis*, of which it is very possibly nothing more than a variety. In his 'Monographie,' Prof. de Koninck has placed *C. volva* among the synonyms of his *C. Dalmaniana*, to which he has added also *C. multidentata*. This last belongs to *C. papilionacea*; but I am convinced that, had my learned friend been able to study the original types of several of M'Coy's so-termed species of Chonetes, he would have arrived at different conclusions.

e.—*Chonetes (Leptaena) perlata*, M'Coy. Synopsis of the Characters of the Carb. Foss. of Ireland, pl. xx, fig. 9 (fig. 25 of my plate).

"Semicircular, nearly twice as wide as long, convex; front margin nearly straight; surface marked with very fine, longitudinal, slightly flexuous striæ; hinge-line with about eight long, slender spines, set nearly at right angles; length three lines, width five and a half lines." (M'Coy, p. 120.)

Loc. Carboniferous slate of Rahoran, Fivemile Town, Ireland.

Obs. Prof. M'Coy states that this species seems closely allied to that which he has figured under the name of *Leptaena serrata*, but is distinguished by its angular plaits and rounded extremities, the radiating ridges being striated transversely. I have examined the original example, and must say that it appeared to me to be nothing more than a small specimen or young shell of *C. Hardrensis*. Prof. M'Coy has exaggerated the inward curve of the spines, and the enlarged illustration of the striæ is not correct, being exactly similar in the specimen to what we find in *C. Hardrensis*.

CHONETES POLITA, M'Coy. Pl. XLVII, figs. 8—11.

LEPTÆNA (CHONETES) POLITA, M'Coy. British Palæozoic Fossils, p. 456, pl. iii D, fig. 30, 1855.

Spec. Char. Shell transversely semicircular, concavo-convex; hinge-line slightly longer than the width of the shell, with a narrow, sub-parallel area in either valve, the ventral one, which is the widest, being divided in the middle by a small fissure, arched over with a pseudo-deltidium, both valves being articulated by the means of teeth and sockets; ventral valve gibbous, much vaulted in the middle and at the beak, which last is small, and does not overlie the cardinal edge; dorsal valve concave, following the curves of the opposite one. Surface of both valves smooth, and marked only by fine, concentric lines of growth, a few scattered spines rising from the surface of the larger valve, and two or three longer ones project from the cardinal edge on either side of the beak. In the interior of the ventral valve the muscular impressions are very feebly marked, and are divided by a small mesial ridge or septum, while pustule-markings rise from the whole remaining surface. In the interior of the dorsal valve, under and a little lower down than the cardinal process, there exists four small impressions left by the adductor or occlusor muscle, while two prominent ridges divide the central pair, and are prolonged to about two thirds of the length of the valve, the remaining portion of the valve being covered with elongated pustular markings. Dimensions very variable; two specimens have measured—

Length $2\frac{1}{2}$, width 3 lines.

„ 2 „ 2 „

Obs. This remarkable little shell is at once distinguished from all its congeners by the smoothness of its valves, as well as by the two peculiarly prominent ridges in the interior of the dorsal valve, and which are likewise present in one or more Silurian species. Prof. M'Coy remarks that this form has much the shape of *C. volva*, but is not so wide, is more gibbous, and is the only Carboniferous species he knows that has a smooth surface.

In England it is stated by Prof. M'Coy to be rare in the dark Carboniferous limestone of Lowick, Northumberland, that it occurs at Mount Rath, in Ireland, and we are indebted to the great zeal of Mr. Young for his discovery in Scotland, and where it occurs in vast

numbers in the Craigenglen beds in Stirlingshire, and, as far as their position is at present known, in the lowest portion of the marine limestone, or close upon the horizon of the Scabricula limestone.

We will now conclude this perhaps unsatisfactory account of the British Carboniferous *Chonetes* by reproducing the description given by Prof. M'Coy of two very doubtful so-termed species.

Chonetes (Leptaena) serrata, M'Coy, Synopsis of the Char. of the Carb. Foss. of Ireland, pl. xviii, fig. 10 (fig. 26 of my plate).

"Semicircular, convex; surface covered with numerous, rather coarse, branched ridges; hinge-line equal to twice the length, straight, furnished with twenty small, hooked spines; breadth ten lines, length five lines. One of the rarest fossils we have." (M'Coy, p. 121.)

Obs. I have seen the original undeterminable fragment upon which this so-termed species has been fabricated, and which was obtained from the lower limestone of Millecent, in Ireland. Prof. de Koninck has referred it to *C. variolata*, but I would not venture to emit any opinion based upon such insufficient material.

Chonetes (Leptaena) tuberculata, M'Coy. Synopsis of the Characters of the Carb. Limest. of Ireland, pl. xx, fig. 5 (fig. 27 of my plate).

"Semicircular, convex; length two thirds the width; surface with about forty-eight thick, rounded, dichotomous, smooth ribs, each bearing towards the margin a row of from five to eight round tubercles.

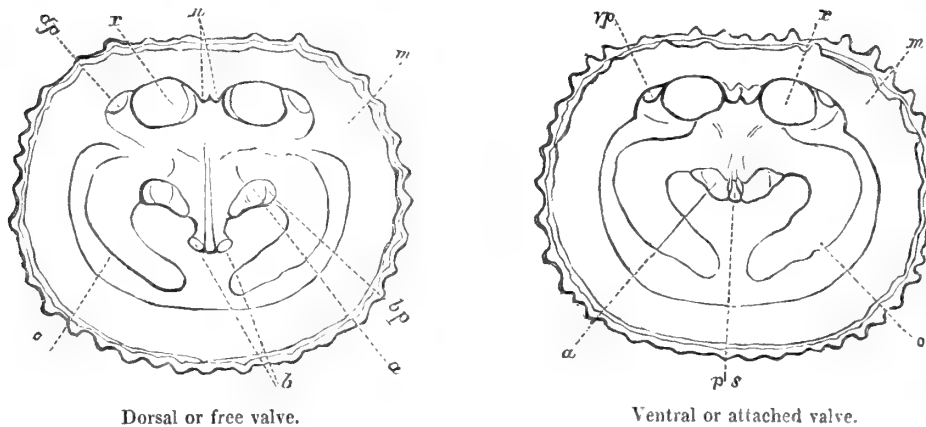
"This curious little species is nearly semicircular, the hinge-line being much shorter than the width of the shell; moderately convex; the radiating ribs are thick, smooth, and distinctly separated, branching as they approach the margin, where they bear a row of six or eight little round tubercles. Length five lines, width eight lines." ('Synopsis,' p. 121.)

Loc. The lower Carboniferous limestone of Millecent, Clare, Ireland.

Obs. I am acquainted with the original specimen, which consists of a single valve, in the collection of Sir R. Griffith, but upon such insufficient material would not venture to pass any decided opinion as to its specific claims.

Family—CRANIADÆ.*Genus*—CRANIA, *Retzius*, 1781.

The shells composing this remarkable and widely spread genus vary much in shape, although not much difference has taken place in this respect in time, for some Palæozoic species can hardly be distinguished from more recent and even living types. They are all marginally more or less circular or sub-quadrate, rarely free, but generally attached to marine bodies by the beak (when such does exist) or by the entire surface of the lower or ventral valve; and it is from this circumstance that the ventral or attached valve varies so much in shape and sculpture. The upper or dorsal valve is always more or less limpet shaped, with a sub-central vertex, the surface being smooth or variously sculptured by concentric or radiating striæ, or ribs, some also possessing a spiny investment. There exists no articulated hinge, the valves being kept in place by a peculiar disposition of the muscles; and although the animal has not been hitherto completely investigated, we will give figures of the interior of the valves, for the sake of explaining the more recent but provisional interpretation and names that have been applied to the muscular impressions by Mr. Hancock. But we must hasten, at the same time, to observe that the interior appearance and shape of the muscular and other impressions are very different in detail in certain species, although very similar in others. The figures here given will, however, suffice to explain the general character.

*Crania Ignabergensis* (var.), Cretaceous.

- a.* Ocluser (Hancock) = anterior adductors (Woodward).
- r.* Divaricator (H.) = posterior adductor (W.).
- v, p.* Ventral adjustor (H.).
- d, p.* Dorsal adjustor (H.) = protractor sliding muscle (W.).
- p, s.* [?] Anterior extremity of dorsal adjustor (H.).
- b, p.* Brachial muscle, posterior extremity (H.) = retractor sliding muscles (W.).
- b.* Brachial muscle, anterior extremity (H.) = retractor sliding muscles (W.).
- n.* Mesenteric muscle, destined probably to draw the alimentary tube backwards (? H.).
- o.* Ovarian (?), *m.* granulated margin.

Mr. Hancock, who, at my request, in May, 1859, examined the animal of three or four badly preserved specimens of *C. anomala* (the only examples then to be procured), has informed me that the impressions *a* are undoubtedly due to the oclusors, *r* to the divaricators, and that when the former muscles relax and the latter contract, the fluid in the perivisceral chamber will be forced forwards, and thus the valves will be opened a little in front, the action being the same as in *Lingula*; that *v, p*, is due to what may be termed the ventral adjustors; that these muscles form a scar close to the outer border of the divaricator in the ventral valve; the other extremities of this muscle converge and pass round the outer margin of the oclusor, to which they adhere, but Mr. Hancock could not exactly determine how they terminate; *d, p*, are considered due to the dorsal adjustors (?), one end of the muscle being attached to the dorsal valve, close to the outer border of the divaricators, the other most probably to the anterior process of the ventral valve. Although this could not be satisfactorily determined, from the very indifferent state of preservation of the specimens, at any rate the fibres of this extremity were firmly united to the inner border of the oclusors. The brachial muscle has both its extremities attached to the same valve (the dorsal), the anterior end to the ventral process, the dorsal close to the outer margin of the oclusor, with which it blends its fibres; that the arms are fixed to these muscles, which, perhaps, may be named the brachial. The mesenteric (*n*) is a flat, thin, membranaceous muscle, binding the dorsal mysentery to the process of the hinge-margin, to which, according to Mr. Woodward, the cardinal muscle is attached; but we may hope that, before long, Mr. Hancock will have been able to investigate anatomically some well-preserved examples, which may be dredged alive, close to some portions of our Scottish or Irish shores. The oval arms are thick, fleshy, and spirally coiled, the volutions are few, and directed vertically towards the cavity of the dorsal valve, somewhat as is seen in *Discina* and other genera. We may also notice that the brachial muscle is very closely united to the oclusor; that it is difficult to distinguish the two in the generality of specimens.

Dr. Carpenter has stated the structure of the shell in this genus to be widely different from that of Brachiopoda generally, but as still conformable to it in being penetrated by canals which are prolonged from the lining membrane of the shell, and which pass towards its external surface, these differing, however, from Terebratulæ in not arriving at that surface, and in breaking up into minute subdivisions as they approach it.

Although three so-termed species of British Carboniferous *Crania* will be here described, *C. quadrata* is the only well-determined species. Of *Crania? trigonalis* I have never seen any other than the original type, and a sight of its interior would be necessary prior to the species being definitely adopted. Of *Crania? (Patella) Ryckholtiana*, De Koninck = *C. vesicularis*, M'Coy, I am acquainted with but a single Irish specimen.

CRANIA QUADRATA, *M'Coy*. Pl. XLVIII, figs. 1—13.

ORBICULA QUADRATA, *M'Coy*. Synopsis of the Char. of the Carb. Foss. of Ireland, pl. xx, fig. 1, 1844.

CRANIA QUADRATA, *Dav.* Mon. of Scottish Carb. Brach., pl. v, figs. 12—21, 1860.

Spec. Char. Very variable in shape, on account of its mode of attachment, which is by the entire surface of its lower valve; when quite regular, is marginally sub-quadrate, almost circular, or slightly elongated, oval, the posterior edge being usually straight, or with a slight inward curve, while the shell is at the same time wider anteriorly than posteriorly. The upper or free valve is conical or limpet-like, the vertex being sub-central and closer to the posterior than to the anterior margin. Externally, the surface is marked with numerous but irregular concentric striæ or lines of growth, which give to the shell a somewhat roughened appearance. The interior of the attached or ventral valve is surrounded by a raised, thickened border, of moderate width, and upon it the tubular shell-structure is sometimes clearly discernible. In each corner of the disc, close to the posterior inner margin of the raised border, may be seen two somewhat circular, slightly convex, and prominent, but widely separated, muscular scars; while towards the centre of the disc two other prominent, but appropriate, muscular impressions exist, and which are, at the same time, somewhat hollowed out along their middle.¹

The interior of the upper or free valve shows in each corner of the disc, close to the posterior inner margin of the border, a convex, oval-shaped, muscular prominence (and which is, according to Mr. Hancock, due to the divaricator muscle), while towards the centre of the valve are two prominent approximate impressions, which are referred by the same authority to the adductor or ocluser muscles. Dimensions very variable; a large example measured—length 7, width 7 lines. The generality of specimens are, however, much smaller.

Obs. The mode of existence peculiar to this as well as to other similarly constructed species is the cause of the great irregularity in shape assumed by the larger number of individuals, for it was the habit of the young of this as well as of other species of the genus to fix themselves as parasites to all kinds of marine objects, and they were sometimes so numerous and closely clustered together that their individual regular growth was prevented, from which it can be easily understood that in such cases the animal must have been compelled to develop itself in whatever direction it could find available space. When first formed, and up to a certain age, the shell of the attached valve was exceedingly thin, and adhered so closely to the surface of the object to which it was fixed as to have

¹ Mr. Hancock attributes the two first-mentioned scars to the divaricator, while the central pair are referred to the ocluser; the other muscular, ovarian, and vascular impressions which should exist in the interior were not sufficiently defined in the present species to admit of their being accurately described.

reproduced all the inequalities of its surface, but with age, and from the shell acquiring greater thickness, these inequalities were generally levelled. Nor is it an uncommon circumstance to find the roughness or sculpture of the object to which the lower valve adheres likewise reproduced upon the outer surface of the upper or unattached valve, in a similar manner to what we find to be the case with certain species of oyster. It is no easy matter to distinguish certain forms of Crania, as several species bear so close a resemblance to each other, and it was not until I had been able to study the original type of Prof. M'Coy's *Orbicula quadrata* (kindly communicated by Sir R. Griffith) that I could identify it with the same form which occurs so abundantly in the Carboniferous shales of Scotland.

In England but few examples have been hitherto discovered; one or two specimens were found by Mr. C. Moore, at Holwell, near Frome. In Scotland it occurs at Gare, in Lanarkshire, at 239 fathoms below "Ell Coal," 343 at Langshaw Burn, and 375 at Kilcadzow. It occurs also at Auchentibber and Calderside, High Blantyre; Capelrig, East Kilbride; Brockley, near Lesmahago; and Robroyston, north of Glasgow. In Ayrshire, at West Broadstone, Beith; Goldcraig, near Kilwinning; Cessnock, near Galston; and on the bank of the stream Pomillen, near Strathavon. In Renfrewshire, at Howood, near Paisley; and Orchard Quarry, Thornliebank. In Kircudbrightshire, in strata cropping out on the seashore, near Kircudbright. In Stirlingshire, in the Balglass Burn beds, and in those of the Campsie main limestone. In Ireland it was found in Carboniferous shale at Rahan's Bay, in Donegal, one mile south-west of Dunkineely village. On the Continent it occurs at Tournay, in Belgium; and at Tuscombia, Alabama, in America.

CRANIA RYCKHOLTIANA, *De Koninck*. Pl. XLVIII, figs. 15, 16, 17?

PATELLA RYCKHOLTIANA, *De Kon.* Animaux Foss. de la Belgique, pl. xxiii, fig. 5, 1843.

CRANIA VESICULARIS, *M'Coy*. Synopsis of the Char. of the Carb. Foss. of Ireland, pl. xx, fig. 3, 1844.

Spec. Char. Ovato-orbicular, nearly circular, or slightly longer than wide. Upper valve conical, limpet-like, the vertex being sub-central and closer to the posterior than to the anterior margin; surface smooth, marked only by a few concentric lines of growth; lower or attached valve unknown. Dimensions variable; two British examples have measured—

Length 8; width 10, depth 6 lines.

„ 12, „ 12, „ 4 „

Obs. It appears quite probable that the *Patella Ryckholtiana* and *Crania vesicularis* belong to the same species, but unfortunately, although several exteriors of the upper valve have been discovered, no example showing the interior has hitherto turned up. In England it has been found in the Carboniferous limestone of Castleton, in Derbyshire.

In Ireland it is mentioned from the limestone of Millecent, in Kildare. No Scottish specimen has hitherto been discovered.

CRANIA? TRIGONALIS, *M'Coy*. Pl. XLVIII, fig. 14.

ORBICULA TRIGONALIS, *M'Coy*. Synopsis of the Carb. Foss. of Ireland, pl. xx, fig. 2, 1844.

Spec. Char. "Conical, obovate, trigonal; anterior end narrow, rounded; posterior sub-truncate; surface irregular, marked with close, rounded, radiating ridges from the beak, which is small, deflexed, and little more than one fourth the length from the anterior margin. Length four and a half lines, width three lines." ('Synopsis,' p. 104.)

Obs. I have reproduced Prof. M'Coy's description, as I know so little about the shell, a single valve having been hitherto discovered, and which was kindly lent me by Sir R. Griffith; and although I would not dare to assert that it positively belongs to the genus *Crania*, it appears to me more probably so than to *Discina*, where placed by the author of the 'Synopsis.' *C.? trigonalis* was obtained from the Calciferous slate of Lisnapaste, in Ireland.

Family—DISCINIDÆ.

Genus—DISCINA, *Lamarck*, 1819.

The shells belonging to this genus are usually circular or longitudinally oval, the larger or imperforated valve being conical, or limpet-like, with the apex inclining towards the posterior margin. The lower valve is conical, opercular, flat, or partly convex, and perforated by a narrow, oval, longitudinal slit, which reaches to near the posterior margin, and which in recent species is placed in the middle of a depressed disc, the shell being always attached to marine bodies by means of a pedicle, and never by the substance of the shell, as in *Crania*. The valves are unarticulated, and kept in place by a particular disposition of muscles, the ocluser and divaricator impressions being somewhat similarly situated to those of *Crania*. Much has still to be done before the animal will have been completely or satisfactorily anatomically investigated. The so-termed oral arms have been described by Mr. S. P. Woodward, in his excellent 'Manual,' as being curved backwards, returning upon themselves, and ending in small spires, directed downwards towards the ventral valve, and the only process which could possibly have afforded support to the arms is developed from the centre of the ventral valve, as in *Crania*. In recent species the shell is stated by Dr. Carpenter to be horny and minutely punctate, the tubuli being generally arranged in fasciculi, so that their transverse sections present a series of dots. Dr. Gratiolet believes, however, that the shell is not entirely composed of a horny substance, but somewhat similar to that of

Lingula, although the calcareous element is enormously greater in the last-named genus. The chemical composition of the shell of *Discina* has been stated by Mr. S. Cloëz to be similar to that of *Lingula*, of which an analysis will be found further on.

Discina appears to have existed during almost the entire series of Palæozoic and Mesozoic periods up to the present day, and it is probable that the animal was not at any period the inhabitant of very deep water, for all the recent species of *Lingula* and *Discina*, or those species with a horny shell, have prevailed in the littoral zone, and do not appear to have descended deeper than about eighteen fathoms. The reader is referred for more ample details to Prof. Suess's excellent 'Memoir on the Habitat and Distribution of the Recent and Fossil Brachiopoda' recently published in Vienna.

One or two British species only have been hitherto found in the Carboniferous rocks.

DISCINA NITIDA, *Phillips*. Pl. XLVIII, figs. 18—25.

ORBICULA NITIDA, *Phillips*. Geol. of York., vol. ii, p. 221, pl. ix, figs. 10—13, 1836.

— *CINCTA*, *Portlock*. Report of the Geol. of Londonderry, &c., pl. xxxii, figs. 15, 16, 1843.

DISCINA BULLA, *McCoy*. British Palæozoic Fossils, pl. iii D, fig. 32, 1855.

— *NITIDA*, *Dav.* Mon. of Scottish Carb. Brach., pl. v, figs. 22—29, 1860.

Spec. Char. Shell marginally circular or elongated oval, the posterior portion being rather narrower than the anterior one. The larger or free valve is conoidal or limpet-like, and more or less elevated, the pointed apex being situated at variable distances between the centre and the posterior margin, but it is not always the most elevated portion of the valve. The surface is covered with numerous small, irregular, concentric wrinkles or striæ. The smaller or lower valve is somewhat flattened or slightly concave towards its anterior margin, with an oval-shaped foramen, surrounded by an elevated, convex margin, which extends from near the centre of the valve to a variable distance from the posterior edge. This valve is likewise ornamented with numerous small, irregular, concentric ridges or wrinkles, with small, flattened interspaces. No interiors have been hitherto obtained. Dimensions variable; three examples have measured—

Length $10\frac{1}{2}$, width 10, depth 6 lines.

„	7	„	$7\frac{1}{2}$	„	3	„
„	7	„	$5\frac{1}{2}$	„	4	„

Obs. After a lengthened examination of *Discina cincta*, as well as of *Discina bulla*, I could perceive no valid grounds for separating these two so-termed species from *D. nitida*; and any one possessing a sufficiently numerous series of specimens of the last-named form would, I think, soon perceive that Phillips's shell presented every degree of elevation—from that of an almost depressed shell to that extreme “inflated, bubble-like

form" described by Prof. M'Coy. I am therefore quite disposed to concur in the Irish author's opinion when he considers *D. cincta* as nothing more than the perfect condition of *D. nitida*; for when the outer surface of the last-named shell is absent, which is often the case, the cast is generally almost smooth, or marked only with a few faint concentric and radiating lines, a circumstance which has apparently led some palæontologists to believe that Phillips's shell was smooth, while that of Portlock's was concentrically striated.

It is also highly probable that the Permian *Discina Koninckii* cannot be specifically separated from the Carboniferous *D. nitida*.

Discina nitida is a common shell in many localities. In England it is mentioned by Prof. Phillips to occur at Bowes, Pateley bridge, Lee Harelaw and Otterburn; also at Coalbrookdale. It has been found also at Lowick, Northumberland; in the upper part of the Carboniferous limestone of Derbyshire, &c. In Scotland it abounds at Belston Place Burn, in Lanarkshire, at 173 fathoms below "Ell Coal," 239 at Gare, 265 at Belston Burn, and 354 at Raes Gill, in the parish of Carluke. It is likewise found at Haw-hill, near Lesmahago; Auchentibber and Calderside, High Blantyre; and Capelrig, East Kilbride. In Renfrewshire, at Arden Quarry, Thornliebank. In Stirlingshire, at Craigenglen, and in the Balgrochen Glen ironstone, &c. In Ayrshire, at Cragie, near Kilmarnock; Cessnock, parish of Galston; and Netherfield, near Strathavon. In Fifeshire, at Strathkenny, St. Andrew's, &c. In Haddingtonshire, at Cat Craig, near Dunbar. It occurs also in Edinburghshire, and along the Berwickshire coast, from the mouth of the Tweed to Ross. In Ireland it occurs at Benburb, Bundoran, Culkagh. In America it has been found in Pike and Adams County, Illinois, &c. &c.

DISCINA DAVREUXIANA, *De Koninck*. Pl. XLVIII, fig. 26.

ORBICULA DAVREUXIANA, *De Koninck*. Desc. des Animaux Foss. du Terrain Carb. de Belg., p. 306, pl. xxi, fig. 4, 1843.

Spec. Char. Shell marginally oval, longer than wide; larger or upper valve conoidal or limpet-like, the apex being situated between the centre and the posterior margin. Surface smooth, with concentric, rounded wrinkles. Lower valve unknown. Length 3, width $2\frac{1}{2}$, depth 1 line.

Obs. I am acquainted with but a single British example, which was found by Mr. Joseph Wright in the Carboniferous limestone of Little Island, near Cork, in Ireland. The specimen bears a close resemblance to the *O. Davreuxiana*, but I am still uncertain whether this last is a good species or only a variety of *D. nitida*, the material at my command not being sufficient to enable me to decide the question. In Belgium it occurs near Tournay.

Family—LINGULIDÆ.*Genus*—LINGULA, Bruguière 1789.

The limit of variation among the shells composing the genus *Lingula* appears to be more restricted than what is prevalent among the generality of other genera and species of Brachiopoda. It is, therefore, very often no easy matter to distinguish and correctly determine some fossil species, even when occurring in different and often widely separate geological periods.

The shell of *Lingula* is thin, equilateral, usually longer than wide, and broader at the front than at the beaks, which are likewise more or less pointed, while the front is either nearly straight or with a slight inward or outward curve. The shell is also sub-equivalve; the extremity of the beak of the dorsal valve being somewhat more elongated and pointed than that of the ventral one.¹ The external surface is also either nearly smooth or concentrically striated. The valves are usually moderately convex, and generally deepest or most elevated towards the beak, and become more flattened as they approach the front. The apex of the dorsal valve is likewise situated quite close to, but not contiguous with, the rounded margin of the beak, and by which character the valves can be readily distinguished both in the recent and fossil condition.

When alive, the valves of *Lingula* were slightly gaping at each end, contiguous only along the lateral margins; but the animal could, at its will, by the action of certain muscles, close or draw together one or other extremity; nor does there exist any articulation, the valves being kept in place by the means of a complicated system of muscles, to be hereafter described. The animal was also provided with a very long pedicle, of a peculiar construction, which was chiefly attached to the inner groove situated in the beak of the ventral valve; and when alive, did not inhabit great depths, most recent species having been found at low water, buried in sand.

The intimate shell-structure of *Lingula* has been described by Dr. Carpenter, and we will therefore only refer to Dr. Gratiolet and Mr. S. Cloëz's more recent observations. The first-named *savant* states that the shell is composed of two distinct elements, the one being horny, the other shelly. That they are disposed in layers, or thin laminæ, which succeed each other alternately from the convex surface of the valves, the outer or superficial one being horny; that these layers have not the same thickness, the testaceous ones being the thickest on and near the visceral side, while the horny ones are more so towards the exterior surface; and that while the horny layers are entirely formed of parallel fibres,

¹ Anatomists appear to differ as to the names by which the valves should be designated; it may therefore be as well to mention those that are synonyms. The shortest is the *dorsal valve* of Woodward, Hancock, &c.; = *valve inférieure*, Gratiolet; = *valve droite*, Vogt. The longest is the *ventral valve* of Woodward, Hancock, &c.; = *valve supérieure*, Gratiolet; = *valve gauche*, Vogt. Mr. Hancock is of opinion that if the names of the valves were to be changed, that they should be called *anterior* and *posterior*. In this monograph we will continue to make use of those first mentioned.

without trace of perforations, the testaceous ones are traversed by a multitude of minute canals, recalling those of the Terebratulidæ.¹ Mr. S. Cloëz has likewise shown that the valves of *Lingula*, when dried at 100°, contain, for 100 parts—

Organic matter	45·20
Carbonate of lime	6·68
Phosphate of lime	42·29
— of magnesia	3·85
— of sesqui-oxide of iron	1·98
Silica	Traces.

This distinguished French chemist observes, at the same time, that this composition of the test of *Lingula* approximates to that which M. Chevreuil signalled in the scales of the *Lepidostria*, as well as to the test of insects as described some years ago by Hatching.

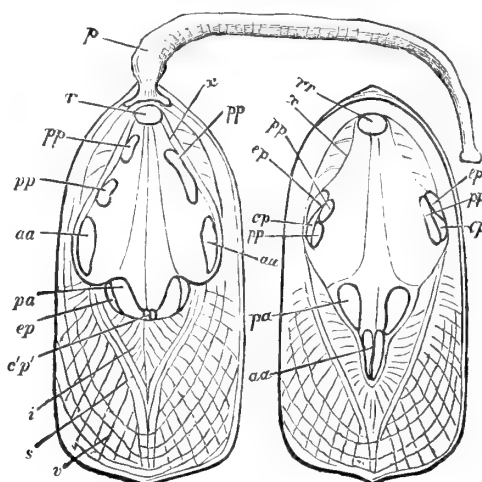


FIG. 1.

FIG. 2.

Lingula anatina (recent).

Fig. 1. *Ventral valve*, Woodward, Hancock, &c.; valve supérieure, Gratiolet.

Fig. 2. *Dorsal valve*, Woodward, Hancock, &c.; valve inférieure, Gratiolet.

- p, a.* Posterior oclusor, Hancock; = anterior adductors, Woodward; = pré-adducteurs, Gratiolet; = untere schiese muskelbündel, Vogt; = muscles qui vont directement d'une coquille à l'autre, Cuvier.
- a, a.* Anterior oclusor, Hancock; = anterior retractors, Woodward; = muscles obliques postero-antérieurs, Gratiolet; = mittlere schiese muskelbündel, Vogt.
- r, r, r.* Divaricator, Hancock; = posterior adductor, Woodward; = post-adducteurs, Gratiolet; = oberer schliessmuskel, Vogt.
- p, p.* Posterior adjustor, Hancock; = posterior retractors, Woodward; = muscles croisé ou oblique transverse, Gratiolet.
- e, p.* External adjustor, Hancock; = external protractors, Woodward; = surface sur laquelle se prolonge l'insertion du muscle oblique antero-postérieur paire externe, Gratiolet.
- c, p,* and *c', p'.* Central adjustor, Hancock; = central protractor, Woodward. *c, p.* Muscles obliques antérieurs paire interne, Gratiolet; and *c', p'*, muscles obliques antérieurs paire interne et externe, Gratiolet.
- x.* Line indicating the posterior parietals, Hancock; = peaussier verticaux, Gratiolet.
- p.* Peduncular muscle, Hancock; = capsule of pedicle, Woodward; = muscle intérieur du pedoncule, Gratiolet.
- i.* Impressions produced by the central branches of sinuses, Hancock.
- s.* Impressions produced by the outer or lateral branches of sinuses.
- v.* Impressions produced by pallial lobe.

¹ I have considered it desirable to reproduce these details, as they are important to British Palæontologists, and have been taken from the first portion of Dr. Gratiolet's recently published memoir on 'The Anatomy of *Lingula anatina*;' and I avail myself of the present opportunity to express my grateful

In the interior of the valves may be seen a number of muscular and other impressions with which the palæontologist should become acquainted, but it would be out of place were we to enter into a minute anatomical description of the animal itself in a work exclusively devoted to fossil species. We will therefore briefly place before the reader a few details only concerning those muscles which have left recognisable impressions in the interior of the valves. It must also be observed that, although Mr. Woodward, Mr. Hancock, Dr. Gratiolet, and others, agree as to the shape and position of the various muscles, they do not interpret the functions of some of these exactly in the same manner, and as a number of names have been applied to designate the same muscle, the first thing to do will be to place before the readers figures showing the position of the impressions and the synonymous terms that have been employed, and these will also save us the necessity of describing the scars, which a glance at the figures will explain far better than could be done by simple words.

The muscular system is much more complex in the unarticulated divisions of the Brachiopoda than in the articulated groups. While describing their shape and direction we cannot do better than to follow what has been said by Mr. Hancock in his admirable memoir upon the "Anatomy of the Brachiopoda," published in the 'Philosophical Transactions of the Royal Society,' 1858:

The *anterior oclusors* "are a pair of stout muscles, of about equal thickness throughout; they pass from the ventral valve, one at each side, in front of the visceral mass, and inclining forwards and inwards, they go to be attached to the sides of the central ridge of the dorsal valve, about one third of the length of the shell from the anterior margin. The dorsal extremities are compressed, and have their sides in contact."

The *posterior oclusors* "are rather stouter and much stronger, and go directly from valve to valve, parallel with each other. The ventral extremities are placed a little in advance of the corresponding terminations of the anterior pair, and the dorsal extremities of the former are situated a little behind those of the latter."

The *divaricator*, "though forming a single mass, is really two muscles combined. It is short and stout, and is situated at the posterior extremity of the perivisceral chamber, passing directly between the valves, and having its attachments immediately within the umbones. The extremities have a semicircular form, arched behind, and slightly bifid in front, indicating its double nature."

thanks to the distinguished French anatomist for the high honour he has conferred by dedicating to me the result of his admirable researches. For details concerning the animal of *Lingula* I must refer the reader to the following memoirs:—Cuvier, 'Mémoire sur l'Animal de la Lingula,' 1797 and 1802. Vogt, 'Anatomie der Lingula anatina,' 1845. Owen, "On the Anatomy of the Brachiopoda," 'Trans. of the Zool. Soc.,' 1835; as well as in Davidson's 'General Introduction,' chap. i, 1853. S. P. Woodward, 'Manual of the Mollusca,' 1854. But especially to the magnificent memoir by Hancock, "On the Organization of the Brachiopoda," 'Trans. Royal Soc.,' 1858. As well as to Gratiolet's most important and excellent memoir, "Études Anatomiques sur la Lingula anatina," in the 'Journal de Conchyliologie,' for January and April, 1860.

The *central adjustors*.—"This pair are attached to the ventral valve by fine points between the posterior oclusors in front; they are placed close together, one on each side of the median line. Sweeping round the inner border of these muscles, they diverge posteriorly, and increasing in size as they go, ascend towards the dorsal valve, to which they become adherent, one on each side, immediately within the parietes of the body."

The *external adjustors* "arise from the ventral valve, at the outside of the posterior oclusors, and in contact with them. They are at first pretty stout, but on passing outwards and backwards they enlarge a little, and ascending, are inserted into the dorsal valve, one on each side, immediately behind the central pair."

The *posterior adjustors* "are large and powerful muscles, and though they may be considered as a pair, they are asymmetrical, there being two on one side and only one on the other. As they pass across from valve to valve they intersect each other, the single one passing between the other two. The single one is as large as the other two both together, and is attached to the left side of the ventral valve, about midway between the divaricator and the anterior oclusor. From this point it passes diagonally upwards and forwards. . . and on reaching the opposite side of the dorsal valve has the other end inserted into the latter, immediately within the posterior terminations of the external and central adjustors of the same side. At the points of attachment the three muscles are pressed so close together that they appear at first sight as only one. The two opposite posterior adjustors take their origin from the right side of the ventral valve, considerably apart; but both of them close to the lateral parietes of the body, one only a little in advance of the divaricator, and the other a short distance further forward. They converge as they penetrate the visceral mass, and sloping forward, one on each side of the visceral muscle, with the alimentary tube above them, they ascend to their insertion into the left side of the dorsal valve, directly within those of the external and central adjustors. Therefore at this point there are the terminations of four muscles in close contact."

The *peduncular muscle* "has its insertion immediately within the umbo of the ventral valve, and close behind the divaricator."

x is a line indicating attachment of the posterior parietals.

There are some other muscles, but as they do not leave any impressions upon the surface of the shell, will not require to be recorded here; but now that the reader has had the names, shape, and direction of the muscles explained, it will be necessary to mention as briefly as possible what are their supposed functions, and for this purpose I will particularly mention the views of Mr. Hancock and Dr. Gratiolet, as they are the authors who have more recently examined the animal with the greatest attention. In order to avoid the possibility of error upon my part, I requested the last-named two anatomists to kindly transmit me their views, which I will now transcribe.

According to Mr. Hancock, the functions of the various muscles might be shortly described as follows:

"The *anterior* and *posterior oclusors* are mainly instrumental in closing the valves.

“The *divaricators* are the chief agents in opening them. When they contract, the umbonal regions of the valves are approximated, and thus pressing forward the fluid in the peri-visceral chamber, their anterior margin is separated.

“The primary function of the three pairs of *adjustors* is to keep the valves opposed to each other, or, in other words, to adjust them, and in this respect to compensate for the deficiency of the hinge and condyles. When in full action and in co-operation with the oclusors and divaricator, they likewise assist in closing the valves. The adjustors are the sliding muscles of those authors who believe in the sliding of the valves over each other. The anterior oclusors have had a similar function assigned to them.

“The *peduncular* muscle attaches the shell to the peduncle, and has probably the power of moving the former upon the latter.”

Some doubt exists concerning the homology of the adjustor muscles (in Lingula), but Mr. Hancock has not expressed any strong opinion on the point; he thought it likely that the muscles so named in the articulated and unarticulated genera of Brachiopoda were probably homologous, but is ready to admit that he may be possibly mistaken, and, if so, he would not, however, be disposed to change the names, for in both divisions the function of these muscles is to adjust the valves. It is only necessary to keep in view that they are *not* homologous.

We will now give Dr. Gratiolet's description of the functions of the muscles, and for which I am indebted to the author himself, who has kindly therein distinguished the effects of *simultaneous action* and those of the *alternate action*; and for the assistance of the reader Mr. Hancock's names have been added within brackets.

1. MUSCLES PRÉADDUCTEURS (posterior adductor) and POST-ADDUCTEURS (divaricators).

a. Simultaneous action.—The energetically drawing together the valves in their whole length.

b. Alternative action.—When the préadducteurs contract themselves alone, they close the shell in front and make it gape behind. When the post-adducteurs contract alone, they close the shell almost completely behind and make it open in front.

2. MUSCLES PEAUSSIERS VERTICAUX (posterior parietal muscles).

a. Simultaneous action.—They depress the body behind, cause the internal fluid to flow towards the arms, and consequently come strongly in aid of the action of the “muscles post-adducteurs.”

3. MUSCLES OBLIQUES TRANSVERSALEMENT, *muscles croisés* of Cuvier (posterior adjustors)

a. Simultaneous action.—They energetically draw together the valves.

b. Alternative action.—Taking for a fixed point the valve which I call the superior

(ventral), the right muscle, causing a traction upon the opposite side of the inferior valve, makes it deviate a little to the right by a sliding, the extent of which I should not know, *a priori*, how to measure. The double-cross muscle of the left side, acting symmetrically, makes it deviate a little to the left.

4. MUSCLES OBLIQUES POSTERO-ANTÉRIEURS (anterior occlusor) *et* ANTERO-POSTÉRIEURS (central and external adjustors).

a. Simultaneous action.—They draw the valves together energetically.

b. Alternative action.—Supposing always the superior (ventral) valve as a fixed point the “muscles postero-antérieurs acting from behind forward upon the inferior (dorsal) valve, make it slide backward. The muscles “antero-postérieurs” acting from the front backward upon the inferior valve, make it slide forward.

N.B.—If one admitted an alternative possible between the longitudinal oblique muscle of the right side and the left side, their movements would evidently come in aid of those of the cross muscles.

5. MUSCLES PÉDONCULAIRES (peduncular muscle) *et* MUSCLES MARGINAUX.

These muscles leave also their traces upon the shell. The first erect (adjust) the body upon the peduncle, and that in two ways—the first by a direct action, in the second place by causing the fluids which fill the internal cavity of the peduncle to ebb into the body. The second act exclusively upon the border of the great pallial lobes.

It will therefore be seen, from what has been stated, that, although anatomists agree as to the shape and position of the muscles, they entertain different views respecting some of their functions. Thus, Mr. Hancock objects entirely to the notion of the sliding of the valves in different directions over each other by the aid of the adjustors (protractor sliding muscles of Woodward¹), a theory first propounded by Cuvier and Owen; while Dr. Gratiolet believes that the cross disposition of certain muscles, whether from behind forward or whether from right to left, would lead one to imagine a compensated antagonism from which equilibrium would result during the simultaneous contraction of all the elements; and that the oblique muscles transversely crossed of Cuvier, his “muscles obliques postero-antérieurs” and “antero-postérieurs,” were employed in the sliding action of the valves. Mr. Hancock, on the other hand, observes that in *Crania*, where the muscular system is arranged after the plan of *Lingula*, there exists *no* sliding movement, and that Mr. Lucas Barrett, who has seen *Crania* alive, has distinctly stated that “the valves open by moving upon the straight side, as on a hinge, without sliding of the valves;” but it would be out of place and presumptuous were I to dwell any longer upon

¹ According to Mr. S. P. Woodward, *Lingula* would possess a pedicle muscle; three adductor muscles, the posterior pair combined; two pairs of retractors, the posterior pair unsymmetrical, one of them dividing; and two posterior sliding muscles.

this controverted question, my object having been attained if I have been able to lay before the geological and palæontological reader the views of two such eminently distinguished anatomists as Mr. Hancock and Dr. Gratiolet, and no doubt time will prove which is the correct interpretation; for now that the question at issue has been made known, it will not be difficult for some observer who may happen to be where *Lingula* is found alive to notice whether or not the valves do slide upon one another. We will now conclude the little we had deemed necessary to say of the animal by observing that the so-termed oral arms are not supported, as in many of the articulated genera, by a more or less complicated system of lamellæ; that they are fleshy, with their spires directed towards each other.

After much examination I have reduced the so-termed species of British Carboniferous Lingulæ to four, viz., *L. squamiformis*, *L. mytiloides*, *L. Credneri* (which may possibly be a variety of *L. mytiloides*), and *L. Scotica*.

LINGULA SQUAMIFORMIS, *Phillips*. Pl. XLIX, figs. 1—10.

LINGULA SQUAMIFORMIS, <i>Phillips</i> .	Geol. of Yorkshire, vol. ii, pl. ix, fig. 14, 1836.
— —	<i>Portlock</i> . Report on the Geol. of Londonderry, &c., pl. xxxii, fig. 5, 1843.
— —	<i>M'Coy</i> . British Pal. Foss., p. 475, 1855.
— —	<i>Dav.</i> Mon. of Scottish Carb. Brach., pl. xi, fig. 14, 1861.

Spec. Char. Shell longitudinally oblong, one third or less longer than wide, with sub-parallel sides, the broadest towards the anterior extremity, the frontal margin assuming either a very slight inward or outward curve. The anterior portion is gradually curved on either side, the beak being rounded or but slightly angular at its extremity in the dorsal valve, with a thickened margin, tapering, pointed retrally at its termination in the ventral one, which is consequently so much longer than the opposite valve. The valves are slightly convex, but somewhat depressed along their middle. In the dorsal one there exists a small apex close to the rounded margin of the beak, and from which usually radiate three small, rounded ridges, separated by shallow sulci. The external surface in both valves is covered with numerous fine, concentric striæ, or lines of growth, giving to the shell a beautifully and delicately sculptured appearance, for the minute plications of growth succeed each other with much regularity, while some stronger lines or interruptions of growth are produced at variable distances. The internal muscular impressions are similar to those already described, the occlusor and external adjustors of Hancock being especially observable. Dimensions variable; two British examples have measured—

Length 19, width 13 lines.

„ 9 „ 6½ „

Obs. This is a common species in certain Scottish strata and localities, and is found likewise in England and in Ireland, and can be distinguished from its congeners by shape

and sculpture, although the Silurian *Lingula granulata* of Phillips approached nearest to it; this last is, however, usually less elongated, and does not present those radiatory ridges which are generally, but not always, observable in the Carboniferous species.

In his work on 'British Palæozoic Fossils,' Prof. M'Coy concludes his description of *L. squamiformis* by stating that "the wide, short, oblong form of this species easily distinguishes it from the others in the upper Palæozoic rocks. The more elongated, narrow, oblong species, well figured in Portlock's 'Geological Report,' tab. xxxii, fig. 5, under this name, might be called *L. Portlocki* (M'Coy). Its proportional width is only 55-100th. in the long, and 60-100th in the short valve." But specimens connecting the narrow and the wider varieties are so numerous that I could not admit the two extremes as distinct species, besides which, Phillips's original example is perfectly similar to many of the Scottish examples of the species, although not very correctly figured in the 'Geology of Yorkshire,' and from which circumstance may have led some to doubt the identity. Phillips's specimen (fig. 1 of my plate), which may be seen in the British Museum, consists of a shell and counterpart, or rather the shell is equally divided between the two sides of a split nodule, so that neither of them show the true structure. When the shell is removed the matrix shows regular, concentric striæ, similar to those above described, but elsewhere only fractured lines of laminæ and radiating striæ. The nodule is black, and the shell dark and pyritous. *L. squamiformis* has sometimes attained comparatively large dimensions; thus, in a coaly shale intercalated between bands of ironstone at one mile to the north of Glasgow millions of specimens may be seen in a crushed or distorted condition, but of which some examples, when perfect, measured about one inch and a half in length. Mr. Rodwell discovered also a specimen one inch two lines in length in a shale at about a mile to the east of Bally Castle (on the north coast of Antrim), but the shell does not usually attain such large proportions. In England it is stated by Prof. Phillips to occur at Bolland; it is found also at Lemmington, Northumberland. In Scotland it occurs at Raes Gill, at 341 fathoms below "Ell Coal," 343 at Hall Craig, 317 at Braidwood Gill, 354 at Langshaw Burn; it is found also at Hall Hill, near Lesmahago; in Renfrewshire at Orchard Quarry, Thornliebank; in Dumbartonshire at Netherwood, near Castlecary; in Stirlingshire in the Mill Burn beds, Campsie main limestone and Corrie-burn beds. It is also found at Bishopsbriggs, three miles north of Glasgow; in Haddingtonshire at Cat Craig, near Dunbar; in Edinburghshire at Wardie (Western Breakwater, Granton); and occurs also in Fifeshire and the Berwickshire coast. In Ireland it has been found to the east of Bally Castle (north coast of Antrim), Leam, Fermanagh, Enniskillen (in shale), &c.

LINGULA SCOTICA, *Davidson*. Pl. XLVIII, figs. 27, 28.

LINGULA SCOTICA, *Dav.* Mon. of Scottish Carb. Brach., pl. v, figs. 36, 37, 1860.

Spec. Char. Shell of an elongated triangular shape, tapering at the beak, slightly rounded laterally and in front. The valves are slightly convex, but much compressed, while the entire surface is covered with numerous minute, concentric striæ, with still wider, flattened interspaces. Interior unknown. Dimensions variable; two examples have measured—

Length 15, width $12\frac{1}{2}$ lines.

„ $6\frac{1}{2}$, „ 5 „

Obs. This remarkable species, which has at times exceeded the proportions above given, is easily distinguished by its triangular shape, tapering sides and beaks, as well as by the delicate and peculiar sculpture which adorns its surface. In shape it approaches to certain exceptional examples of Phillips's *Lingula cuneata*, but the Carboniferous and Silurian species cannot be confounded.¹

L. Scotica has not been hitherto discovered either in England or in Ireland. In Scotland it occurs at Gare, in Lanarkshire, at 239 fathoms below the “Ell Coal,” and from which locality it has been known to a friend in Carlisle for upwards of thirty years. My attention was, however, first directed to the shell by Mr. Young, of the Hunterian Museum, Glasgow, who had been struck by its peculiar triangular appearance, and it was subsequently discovered at Robroyston, north of Glasgow, in beds upon a similar horizon to those of Gare, while the larger examples were procured by Dr. Simon from Hall Hill, Auchenheth, and Coalburn, Lesmahago, about 300 fathoms below “Ell Coal.”

LINGULA MYTILOIDES, *Sowerby*. Pl. XLVIII, figs. 29—36.

LINGULA MYTILOIDES, *Sow.* Min. Con., tab. xix, figs. 1, 2, 1812.

— ELLIPTICA, *Phillips*. Geol. of York., pl. xi, fig. 15, 1836.

— MARGINATA, *Phillips*. Ib., fig. 16, 1836.

— PARALLELA, *Phillips*. Ib., figs. 17—19, 1836.

— MYTILOIDES and L. PARALLELA, *Portlock*. Report on the Geol. of London-derry, &c., pl. xxxii, figs. 6—9, 1843.

— — *De Koninck*. Desc. des Anim. Foss. de Belgique, pl. vi, fig. 9, 1843.

— — *Dav.* Mon. of Scottish Carb. Brachiopoda, pl. v, figs. 38, 43, 1860.

¹ I possess also an American *Lingula* from the Potsdam Sandstone of the Falls of St. Croix, Minnesota, which is stated by Mr. Worthen to be the oldest American species of the genus. In shape it is very similar to *L. Scotica*, but differs from it in sculpture, as well as in the convexity of its valves.

Spec. Char. Shell very variable in shape, but usually more or less regularly elliptical or ovate, with its greatest width either towards the posterior or anterior extremity. Its sides are also sometimes nearly parallel and rounded in front, but both front and beaks are in some examples about equally and regularly elliptically attenuated. The valves are generally gently convex, and most elevated along the middle, where there exists likewise a flatness, which becomes gradually wider as it extends from the apex of the beak to the front, the lateral portions of the valves sloping rather abruptly on either side, while the surface is marked at intervals by a greater or smaller number of concentric ridges or lines of growth. Interior unknown. Dimensions variable; three British examples have measured—

Length 10, breadth $5\frac{1}{2}$ lines.

„ 7 „ $3\frac{1}{2}$ „

„ 5 „ $1\frac{1}{2}$ „

Obs. After the examination of a considerable number of specimens, it has appeared to me that *L. parallela* and *L. elliptica* are only slight variations in shape of Sowerby's *L. mytiloides*? Some palæontologists will, however, probably differ with me in this conclusion, and may prefer retaining *L. mytiloides* and *L. parallela* as separate species, and I should be glad to adopt their views if they can point out the characters by which the two can be distinguished. It will, perhaps, be as well, therefore, to reproduce the original description and figures. Sowerby describes *L. mytiloides* as follows:

“Ovate, anterior end slightly truncated; beak indistinct. Nearly an inch long, and three fifths wide; the older shells are flattened towards the front, with rather a straightish edge. Shining, and of a grayish-blue colour.

“These are mostly found in pairs at Wolsingham, in the county of Durham, in a dark-coloured limestone. I am told they are sometimes larger than the figure. They are preserved so well that they have the appearance of a recent mussel.”

Phillips describes his species as follows:

“*L. elliptica*.—Long, elliptical, acuminate retrally, surface with delicate, radiating, and concentric lines. Ashford, in Derbyshire.

“*L. marginata*.—Very oblong, with parallel sides, truncate in front, rounded retrally; edges of the valves turned up; slight mesial ridge on a flat space; small, oval hollow, fine radiating and concentric lines. Bowes.

“*L. parallela*.—Magnified views of a species which seems different from the last by its rounded front and equally convex surface. Northumberland.”

Besides the English localities above given I have seen specimens from the Carboniferous shales of Brakewell and Ashford, in Derbyshire; Denwich, Northumberland. In Scotland it occurs abundantly in slaty ironstone in the parish of Carluke, in Lanarkshire, at 160 fathoms below the “Ell Coal,” 239 at Gare, 300 at Mashock Burn, 237 at Raes Gill, Braidwood, and Langshaw Burn, 371 at Kilcadzow. It occurs likewise at Hall Hill, near Lesmahago, Capelrig, East Kilbride; Calderside and Auchentibber, High Blantyre;

Bishopbriggs and Robroyston, north of Glasgow. In Renfrewshire at Orchard Quarry, Thornliebank. In Ayrshire at West Broadstone, Beith. In Stirlingshire at Craigenglen and Corrieburn. In Fifeshire, at Craig Hartle, &c. It has also been found along the Berwickshire coast, and at Marshall Meadows, three miles north of Berwick. In Ireland it has been found in Tyrone, Desertcreat, also at Clogher (Pollock). On the Continent it has been described by Prof. de Koninck, from Visé, in Belgium.

LINGULA CREDNERI, *Geinitz*. Pl. XLVIII, figs. 38—40.

LINGULA CREDNERI, *Geinitz*. Versteinerungen der Zechteingebirges, pl. iv, figs. 23—29, April, 1848.

— — *M'Coy*. British Palæozoic Fossils, p. 474, 1855.

— — *Kirkby*. Proceedings of the Geol. Soc., vol. xvi, p. 412, 1860.

Spec. Char. Shell small, oval, occasionally oblong, with the posterior end acuminate valves gently convex; marked with concentric lines of growth. Interior unknown. Length 3, width $2\frac{1}{2}$ lines.

Obs. Is this shell specifically distinct from *L. mytiloides*? Might it not be a small variety of the last-named shell? Indeed, I would hardly venture to positively assert that it is specifically distinct. Until March, 1860, *L. Credneri* was known only from the "marl slate" and the lower beds of the compact limestone of the Permian system, but Mr. Kirkby informs us that the shell occurred to him as a Carboniferous species at Ryhope Winning, near Sunderland, in the summer of 1858; that he observed it first in a thin bed of dark shale, at a depth of 951 feet from the surface, or 592 feet from the base of the overlying Permian strata, though in this bed it was exceedingly rare; but that he found it more plentiful in a thick stratum of gray shale just above the bed already mentioned. That from the first (to use his own expression) he was struck with the resemblance of these *Lingulæ* to the Permian species, *L. Credneri*, and that his opinion was only strengthened by the acquisition of a full suit of specimens, and which he submitted to Mr. Hancock's and my own examinations.

There is no essential difference (he adds) between the Permian and Carboniferous specimens. The form of both is nearly oval; the Carboniferous specimens have the median elevation more prominent than those of the marl state, but that in this respect they only approach more closely to the Permian example from the Kupsfer Schiefer, the German equivalent of the marl slate, and that in no respect do the Permian examples differ from the Carboniferous specimens more widely than do individuals of the same series from each other.

LINGULA LATIOR, *M'Coy*. Pl. XLVIII, fig. 37.

LINGULA LATIOR, *M'Coy*. British Palæozoic Fossils, pl. iii D, fig. 33, 1855.

Spec. Char. "Broad-ovate anteriorly, gradually acuminate posteriorly; moderately convex towards the beak, very gradually flattened towards the margins; sides meeting at the beak at an angle of about 75° ; front wide, semi-elliptically rounded; greatest width at about the middle of the length, whence the posterior end is rapidly narrowed to the beak. Surface with fine, sharply defined, strong, close, elevated, obtuse, concentric striæ, slightly irregular from occasional branchings and interruptions; crossed in parts by longitudinal microscopic striæ. Length $4\frac{1}{2}$ lines, proportional width $\frac{80}{100}$." (*M'Coy*, p. 475.)

Obs. I have never seen this so-termed species, although stated by Prof. *M'Coy* to be not very uncommon in the black limestone over the main limestone of Derbyshire. It is therefore provisionally given on the authority of Prof. *M'Coy*, and until the species? may have been completely studied.

PLATE XXVII.

CARBONIFEROUS SPECIES.

FIG.			
1.	Streptorhynchus	crenistria, <i>Phillips</i> .	Carboniferous limestone, Kildare, Ireland.
2, 3, 4.	„	„	var. senilis, <i>Phillips</i> . Fig. 2. The original specimen, C. limestone, Bolland. British Museum.
5.	„	„	From Park Hill, Longnor, Derbyshire. Museum of Practical Geology.
6, 7.	„	„	A fragment of dorsal valve, showing the cardinal process and dental sockets.
8.	„	„	var. Kellii, <i>M'Coy</i> . The original example, C. limestone, Monaghan, Ireland.
9.	„	„	var. cylindrica, <i>M'Coy</i> . The original specimen, from Arenaceous limestone of Castle Espie, Comber, Ireland.
10.	„	„	var. quadrata, <i>M'Coy</i> . The original specimen, Calp of Ballintrillick, Bundoran, Ireland. 8, 9, 10. From Sir R. Griffith's collection.

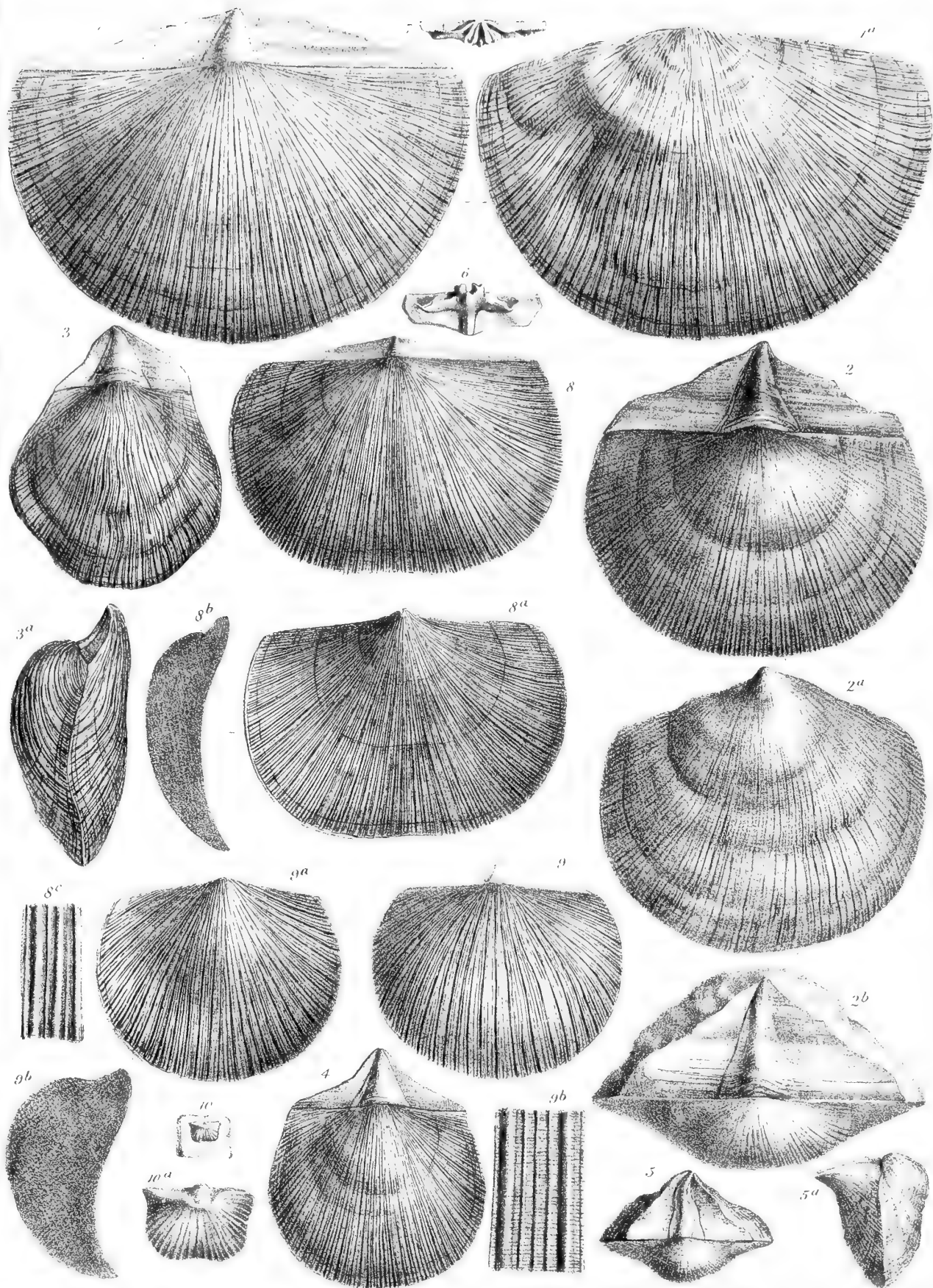


PLATE XXVIII.

CARBONIFEROUS SPECIES.

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|---------|---|--|
| FIG. | | |
| 1 to 6. | <i>Strophomena analoga</i> , <i>Phillips</i> . | Different specimens from the Carboniferous limestone of Kildare, in Ireland; Longnor, in Derbyshire; and Corrieburn, Stirlingshire. |
| 7. | ,, ,, | var. <i>distorta</i> , <i>Sow.</i> Lanarkshire, Scotland. |
| 8. | ,, ,, | ,, A very young shell of the same. |
| 9. | ,, ,, | Interior of the ventral valve, in which the foraminal aperture is cicatrized. |
| 10. | ,, ,, | Interior of the dorsal valve. |
| 11. | ,, ,, | Internal cast, seen from the front, showing the vascular impressions (enlarged). |
| 12. | ,, ,, | A fragment of the ventral valve, showing the position of the foraminal aperture. |
| 13. | ,, ,, | The same, seen from the exterior, showing the foramen. |
| 14. | <i>Orthis Keyserlingiana</i> , <i>De Koninck</i> . | From the Carboniferous limestone of Settle, in Yorkshire. |
| 15. | <i>Orthis?</i> <i>antiquata</i> , <i>Phillips</i> . | From the figures in the 'Geology of Yorkshire.' 15 ^{a, b, c, d} . Enlarged representations, drawn from the original specimens, Bolland. British Museum. |

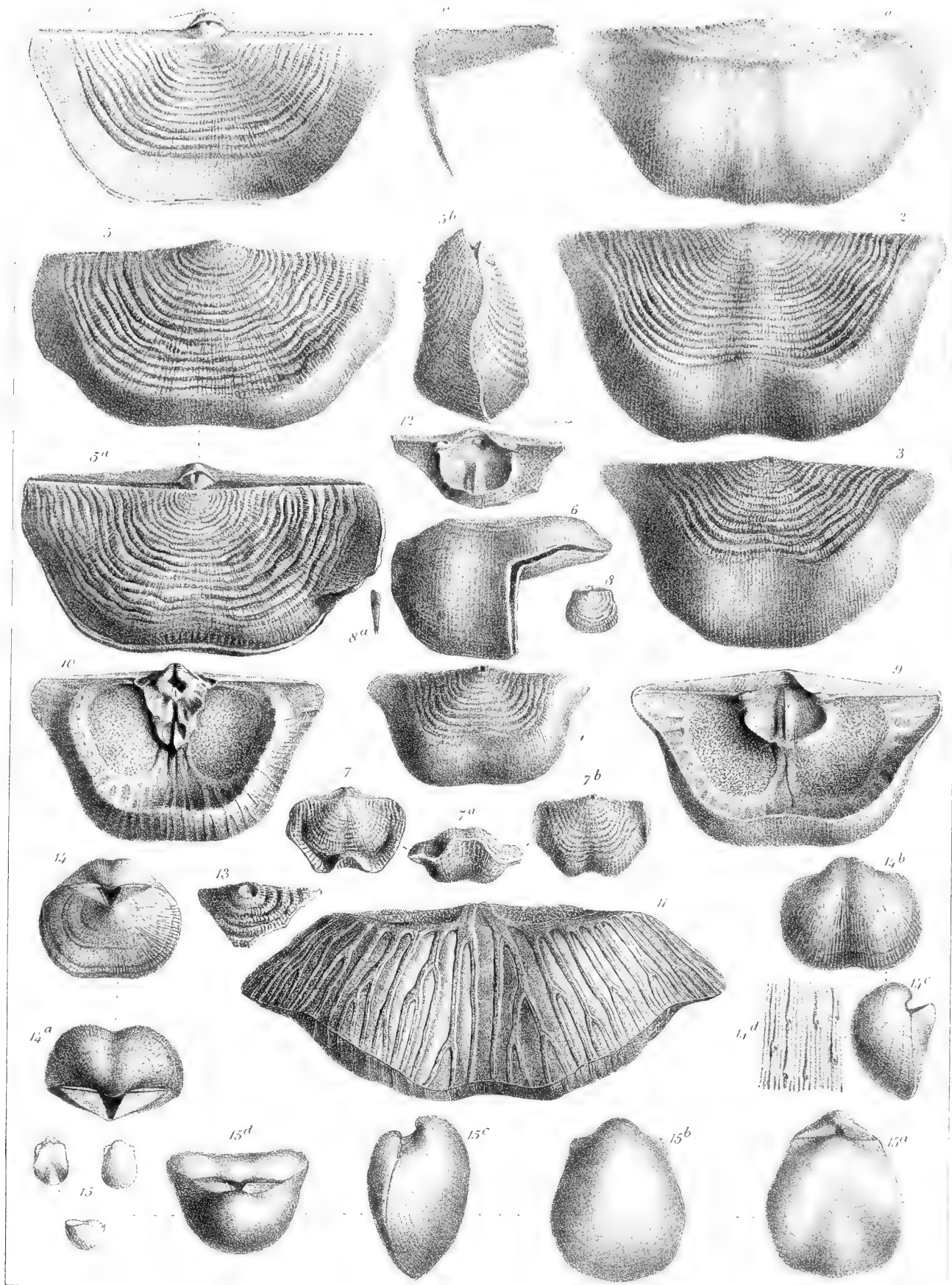


PLATE XXIX.

CARBONIFEROUS SPECIES.

FIG.

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|-------|---------------|-------------------------------------|--|
| 1. | <i>Orthis</i> | <i>resupinata</i> , <i>Martin</i> . | From the Carboniferous limestone of Bolland.
British Museum. |
| 2. | „ | „ | A very large example from Yorkshire. |
| 3. | „ | „ | A globose variety from Withgill, in Yorkshire, and collection of Mr. Parker, of Manchester. |
| 4. | „ | „ | Another example, seen from the front. |
| 5. | „ | „ | var. <i>gibbera</i> , <i>Portlock</i> . From the lower limestone of Cornacarrow, Enniskillen, and collection of Sir R. Griffith. |
| 6, 7. | „ | „ | var. <i>connivens</i> , <i>Phillips</i> . Carboniferous limestone of Little Island, near Cork, Ireland, and collection of Sir R. Griffith. |

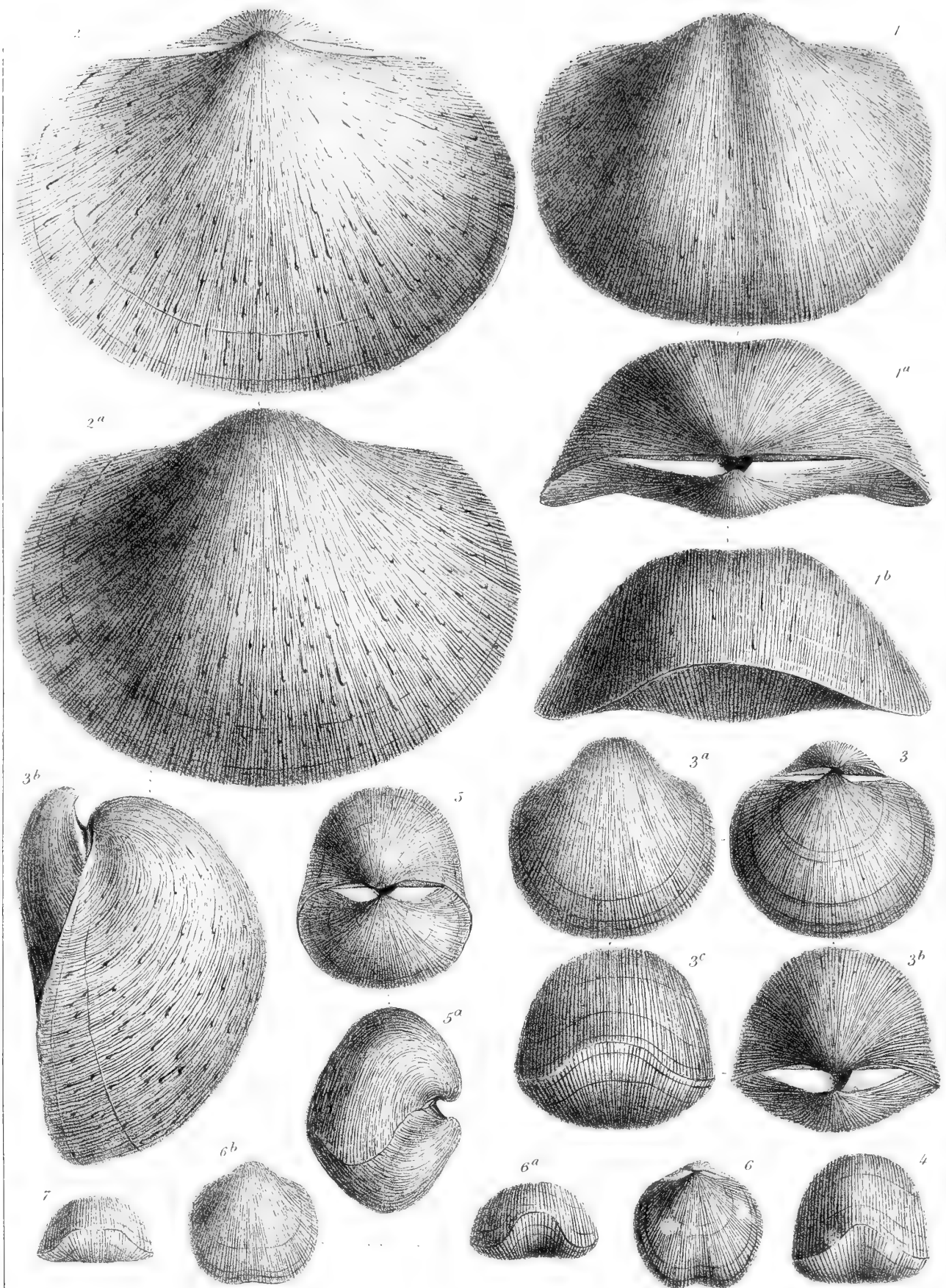


PLATE XXX.

CARBONIFEROUS SPECIES.

- FIG.
1. *Orthis resupinata*, *Martin*. Carboniferous limestone, Millecent, Ireland.
1^d. Portion of the surface, enlarged.
2. „ „ Interior of the dorsal valve, Derbyshire.
3. „ „ Interior of the ventral valve. A, Occlusor; R, divaricator, muscular impressions. Both 2 and 3 belong to the same specimen.
4. „ „ Interior of the dorsal valve. A, Adductor or occlusor muscular impressions; j, cardinal process. Carboniferous shales, Ulverston, Lincolnshire.
5. „ „ Interior or ventral valve, shales near Settle.
- 6, 7, 8, 9. *Orthis Michelini*, *L'Eveillé*. 6. From the Carboniferous shales of Clattering Dykes, Malham Moor, Yorkshire.
7. From shales, Gateside, near Beith, Scotland. 8, 9. From Carboniferous limestone, Millecent, Ireland.
10. „ „ Interior of the dorsal valve (enlarged). j, Cardinal process; A, adductor or occlusor muscular impressions. Gateside, Ayrshire.
11. „ „ Interior of the ventral valve (enlarged), same locality. A, Adductor or occlusor; R, cardinal or divaricator, muscular impressions. Mr. Hancock is of opinion that the upper portion of this impression, or that nearest the beak, may belong to the ventral adjustor, and that N may also perhaps be caused by the pedicle. o, Ovarian spaces.
12. „ „ ? Carboniferous limestone, Settle, Yorkshire. A similar shell to this is described under *O. Michelini* by Prof. de Koninck, in his work on the 'Animaux fossiles de la Belgique,' pl. xiii, fig. 8, but was afterwards believed to be, perhaps, different. Having examined many examples, I am disposed to consider it only a slightly modified condition of L'Eveillé's species.
13. *Streptorhynchus crenistria*, var. *senilis*. A very globose example, from the Carboniferous limestone of Bowertrapping, near Dalry, in Ayrshire, and collection of Mr. J. Thomson.
14. „ „ var. *senilis* (deprived of its outer surface or sculpture). From the Carboniferous limestone of Settle, Yorkshire.
15. „ „ This is the valve described as *Leptaena anomala*, Sow., in pl. 615, fig. 1^b (not ^a, ^c or ^d) of the 'Mineral Conchology,' and as *Strophalosia striata* by Prof. Morris, at p. 155 of his 'Catalogue;' but an attentive study of the specimen and of other similar examples has convinced me that it is none other than an imperfect, contorted valve of *S. senilis*, of which the outer layer or sculpture has been obliterated. Traces of the striæ may, however, be noticed here and there upon its surface.

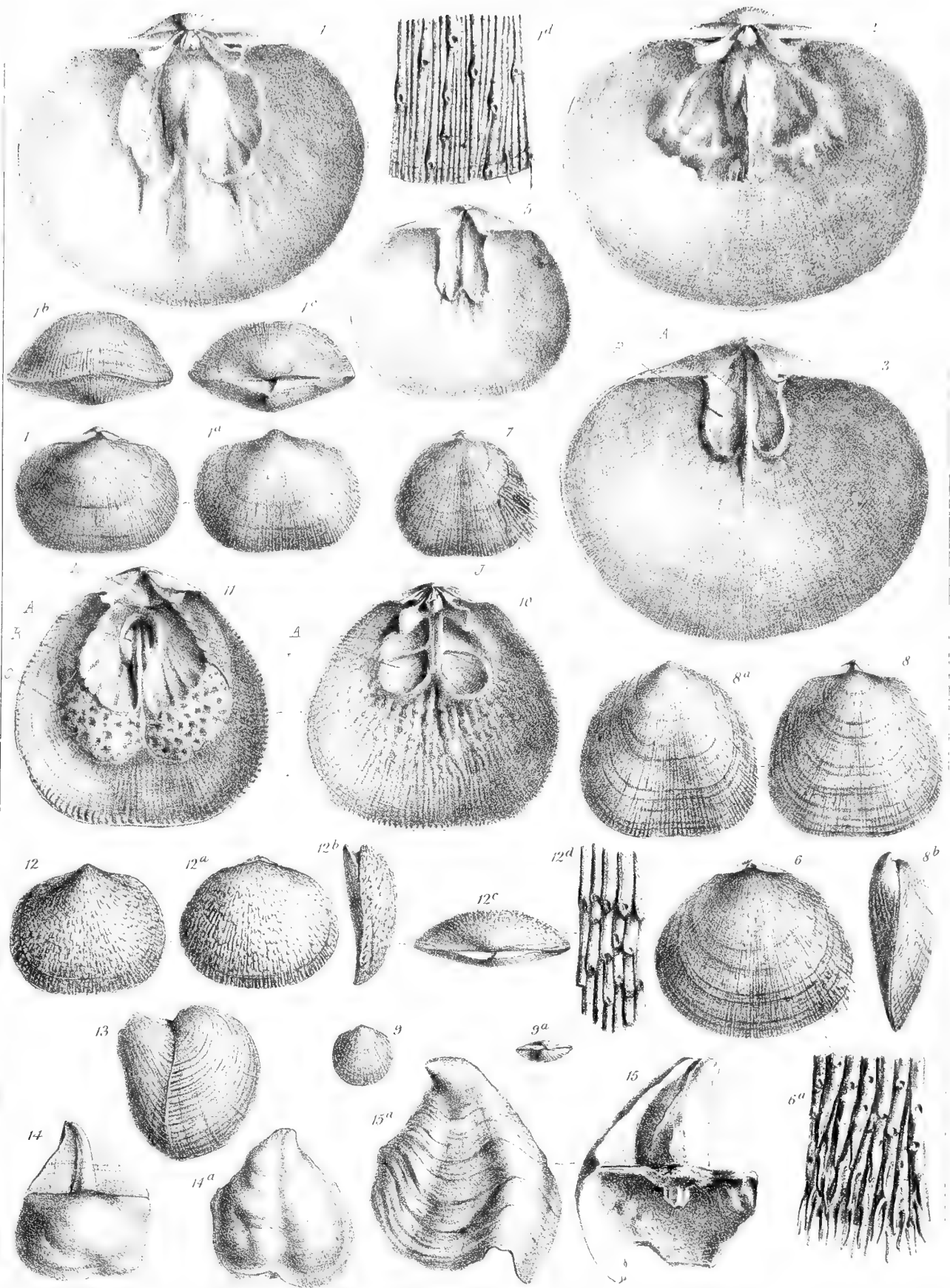


PLATE XXXI.

CARBONIFEROUS SPECIES.

FIG.

1. *Productus sub-lævis*, *De Koninck*. Stated to be from the Carboniferous limestone near Leek, in Staffordshire (but probably from Clitheroe, in Lancashire). Coll. of Dr. Bowerbank.
2. „ „ From the Carboniferous limestone of Llangollen. Museum of Practical Geology, London.
3. „ *plicatilis*, *Sow.* From the limestone of Longnor, Derbyshire. Museum of Practical Geology.
4. „ „ From the limestone of Settle, in Yorkshire.
5. „ „ Internal cast of the ventral valve, from Longnor, in Derbyshire, showing the position of the adductor and divaricator muscular impressions.
6. „ *mesolobus*, *Phillips*. A remarkably circular example from the Carboniferous limestone of Settle, in Yorkshire.
- 7, 8. „ „ Two specimens of the more common shape, from Yorkshire.
9. „ „ From the Glarat limestone, Campsie, Stirlingshire, Scotland.

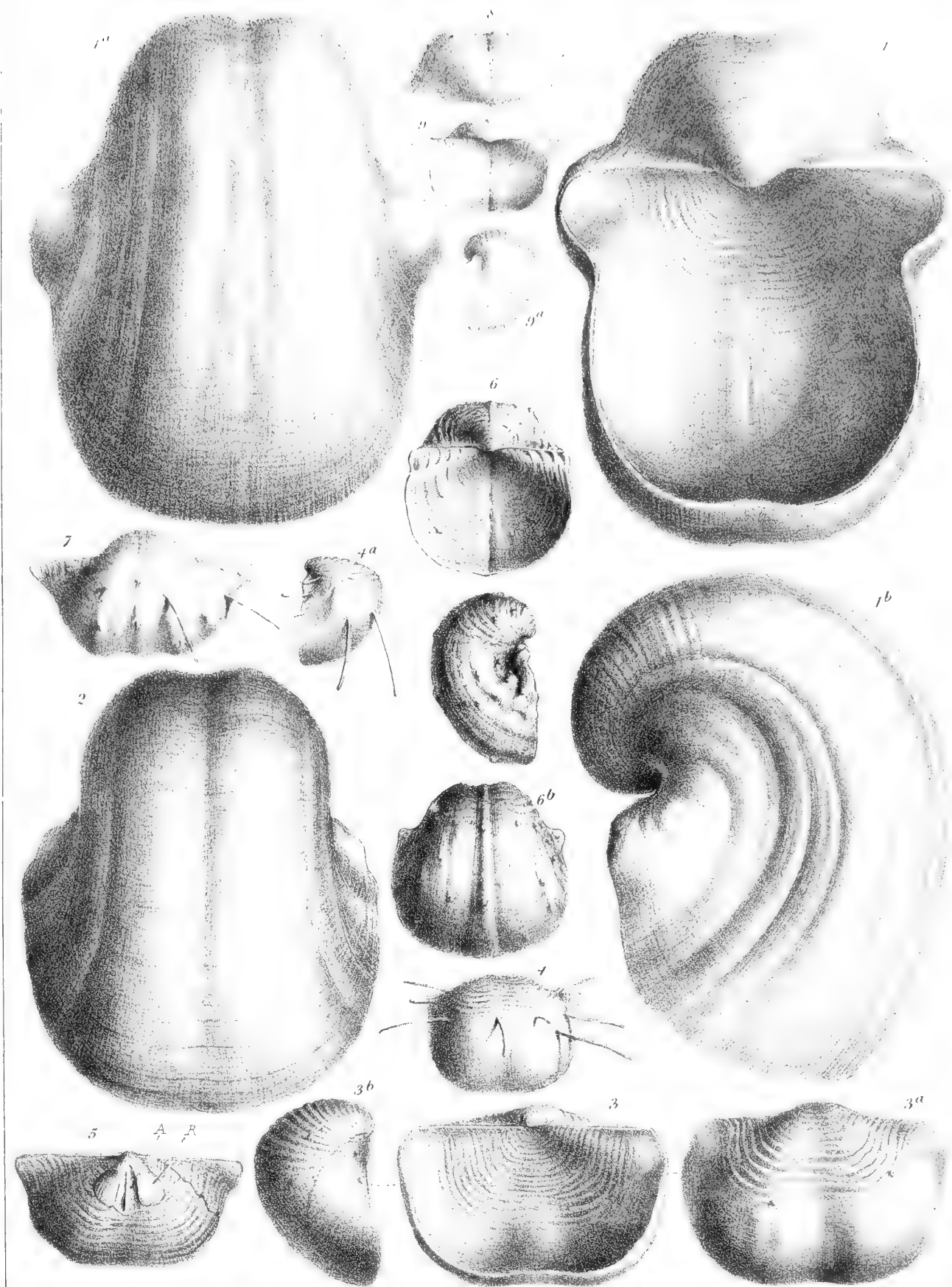


PLATE XXXII.

CARBONIFEROUS SPECIES.

FIG.

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|----------|-------------------------|---|
| 1. | Productus sub-lævis? | These are Prof. de Koninck's figures of <i>P. Christiani</i> , but which appear to me only a slightly modified condition of <i>P. sub-lævis</i> ? Carboniferous limestone, England (the exact locality is not given, but was, perhaps, Clitheroe, in Lancashire.) |
| 2. | ,, costatus, Sow. | A specimen, with its spines, from Carboniferous shales near Glasgow. |
| 3. | ,, ,, | From Richmond, Yorkshire. Collection of Mr. S. Wood. |
| 4. | ,, ,, | From the limestone of Settle, in Yorkshire. |
| 5, 6, 7. | ,, ,, | Three different specimens from Richmond, in Yorkshire, and Lesmahago, Lanarkshire, Scotland. |
| 8. | ,, ,, | Interior of the dorsal valve, from Scotland, and collection of Mr. J. Thomson. |
| 9. | ,, ,, | A very fine, ribbed specimen, forming a passage into the variety <i>P. muricatus</i> , from Howood, Renfrewshire, Scotland, and collection of Mr. J. Thomson. |
| 10, 11. | ,, muricatus, Phillips. | Fig. 10 is taken from the figure in the 'Geology of Yorkshire,' 11 from the original specimen found at Harelaw, and now in the York Museum. |
| 12. | ,, ,, | From the limestone of Gateside, near Beith, in Ayrshire. |
| 13. | ,, ,, | From Corrieburn, Stirlingshire, and collection of Mr. J. Young. |
| 14. | ,, ,, | Another example from the same locality, enlarged. |

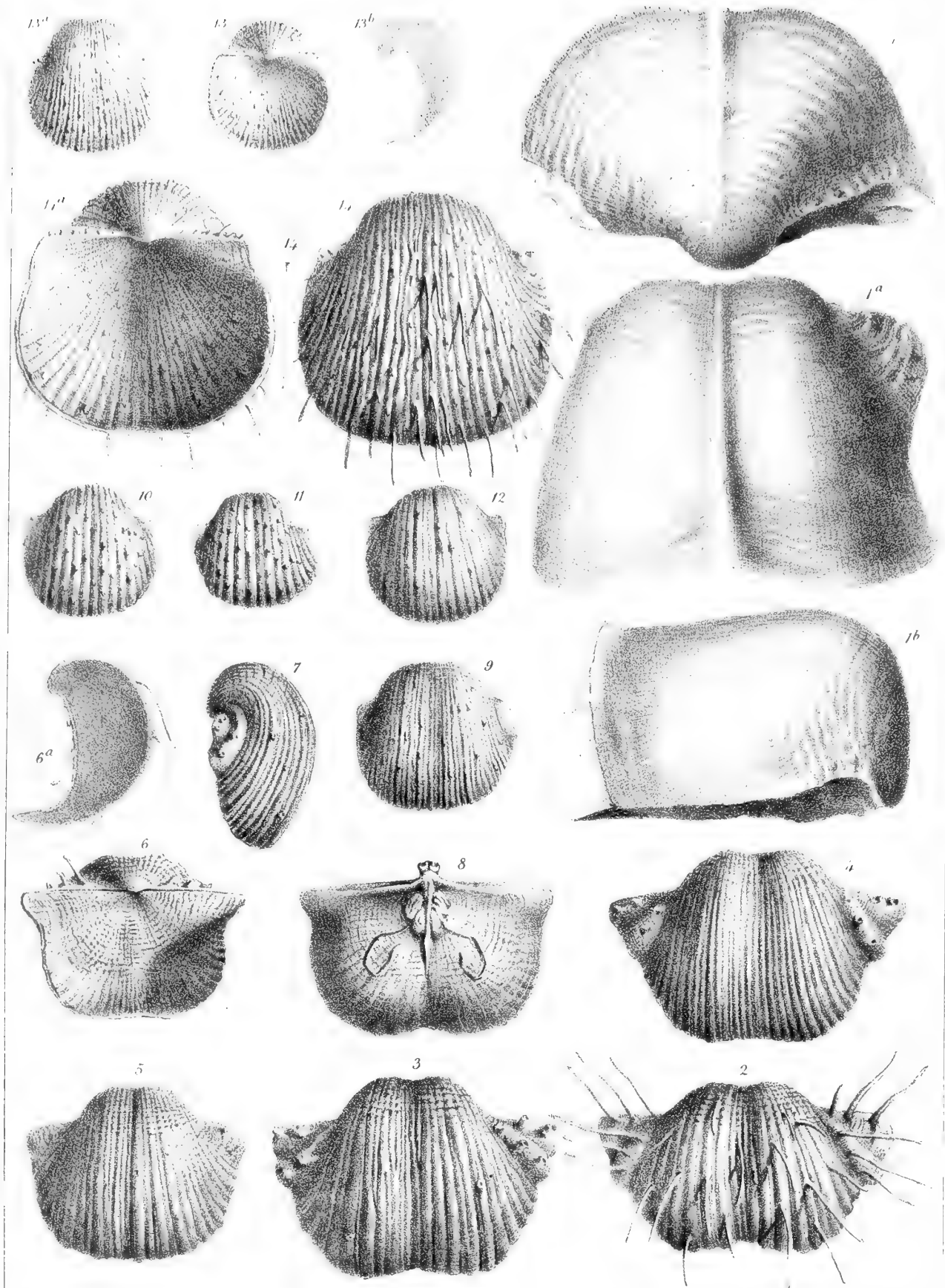


PLATE XXXIII.

CARBONIFEROUS SPECIES.

FIG.

- | | | |
|---------|--|--|
| 1 to 4. | <i>Productus proboscideus</i> , <i>De Verneuil</i> . | Carboniferous limestone, Settle, Yorkshire. I avail myself of the present opportunity to thank my zealous friend, Mr. Burrow, for the liberal and generous manner with which he has presented me with his best and, by me, figured specimens of <i>Producta</i> . |
| 5. | „ <i>ermineus</i> , <i>De Koninck</i> . | Carboniferous limestone, Settle, Yorkshire. |
| 6, 7. | „ <i>Wrightii</i> , <i>Dav</i> . | Carboniferous limestone, Middleton, near Cork, Ireland. Fig. 6 in the collection of Mr. J. Wright, of Cork. |
| 8, 9. | „ <i>sinuatus</i> , <i>De Koninck</i> . | Fig. 8, nat. size; 8 ^{a, b, c} enlarged. 9. Enlarged view of the ventral valve, as seen from the beak, to show the position of the cardinal spines, &c. Carboniferous limestone, Settle, Yorkshire. |
| 10, 11. | „ „ | Internal casts of both valves, showing the position of the adductor (A) and divaricator (R) muscular impressions, as well as the reniform impressions (Z). |
| 12. | „ <i>fimbriatus</i> , <i>Sow</i> . | Ventral valve, with its spines. Carboniferous limestone, Settle, Yorkshire. |
| 13, 14. | „ „ | Two examples deprived of their spines, from the same locality. |
| 15. | „ „ | 15 ^a , interior of the dorsal valve; 15 ^c , the same, viewed in profile; 15 ^b , the same specimen, seen from the exterior, and showing how the short spines are arranged in regular rows. Carboniferous shales, near Settle, Yorkshire. |
| 16. | „ <i>aculeatus</i> , <i>Martin</i> . | From the original example. 16 ^b . A carefully enlarged illustration. Sowerby's collection, British Museum. |

FIG.			
17.	<i>Productus aculeatus</i> .	Another similar example, but with a longer hinge-line. Limestone, Settle.	
18.	„ „	var. <i>P. laxispina</i> , Phillips. From the figure in the 'Geology of Yorkshire.'	
19.	„ „	A large, older, and more spiny example, from Chrome Hill, Longnor, Derbyshire. Museum of Practical Geology.	
20.	„ „	<i>P. spinulosa</i> , Phillips (not Sow.) From the figure in the 'Geology of Yorkshire' (pl. vii, fig. 14).	
21.	„	<i>Youngianus</i> , <i>Dav.</i> From the Carboniferous limestone of Corrie-burn, Stirlingshire, and collection of Mr. J. Young.	
22.	„ „	From Bolland.	
23.	„ „	From Settle, Yorkshire.	
24.	„	<i>tessellatus</i> , <i>De Koninck</i> . From the Carboniferous limestone, Isle of Man, nat. size.	
25.	„ „	A specimen deprived of its fringes, from Settle, in Yorkshire.	

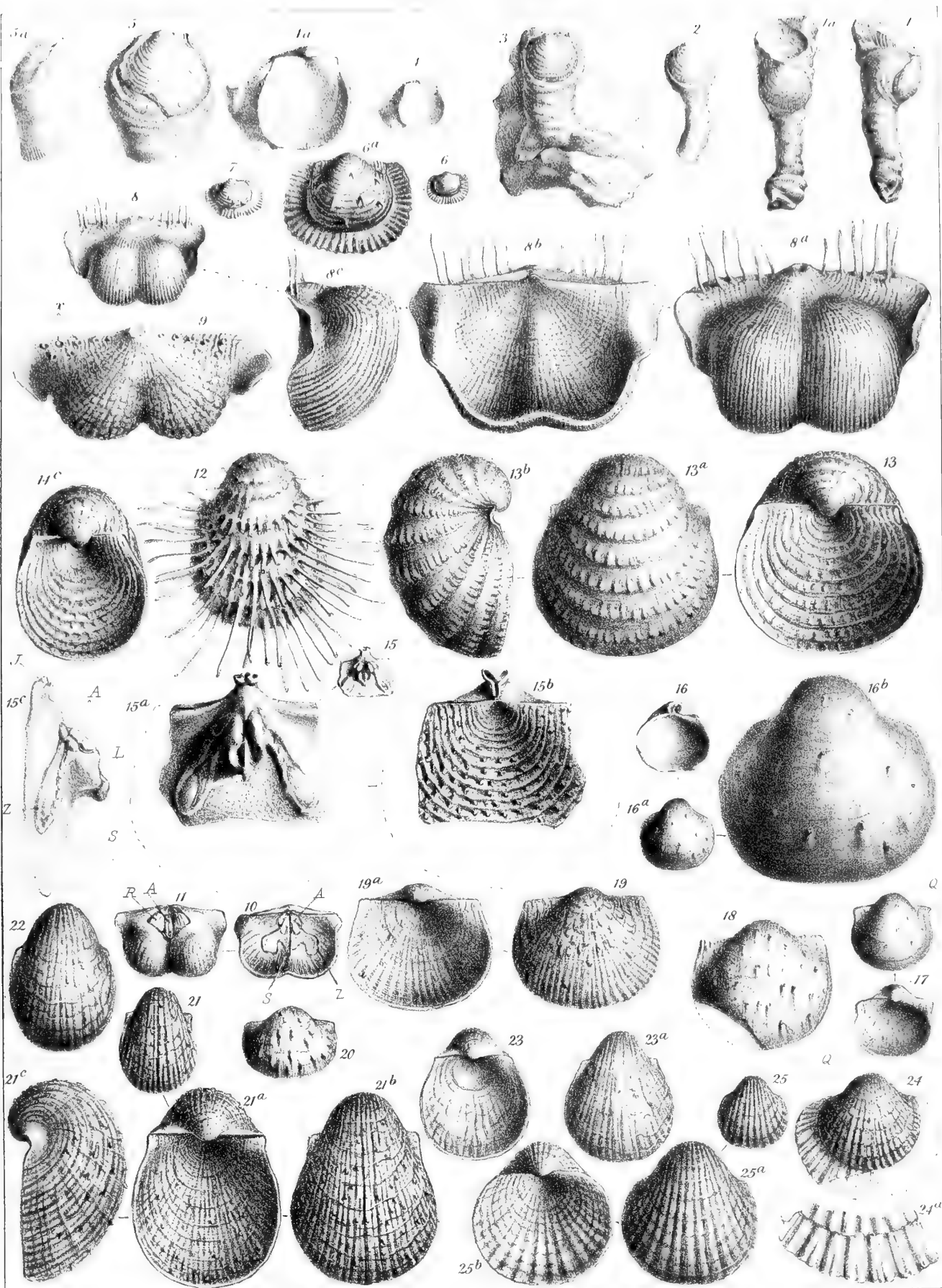


PLATE XXXIV.

CARBONIFEROUS SPECIES.

FIG.		
1.	<i>Productus striatus, Fischer.</i>	Carboniferous limestone, Longnor, Derbyshire. Museum of Practical Geology.
2.	„ „	Limestone, Settle, Yorkshire.
3.	„ „	„ „ Derbyshire.
4, 5.	„ „	„ „ Malformations. Museum of Practical Geology.
6.	„ <i>carbonarius, De Koniuck.</i>	Carboniferous limestone north of Glasgow. Museum of Practical Geology.
7.	„ <i>undatus, De France.</i>	Derbyshire. Collection of Dr. Fleming, of Manchester.
8.	„ „	Limestone, Poolwash, Isle of Man.
9.	„ „	„ „ Settle, Yorkshire.
10, 11, 12.	„ „	„ „ Campsie, Stirlingshire.
13.	„ „	<i>P. tortilis</i> , M'Coy. Limestone, Tullanaguiggy, Fermanagh, Ireland, and collection of Sir R. Griffith.
14.	„ <i>tessellatus, De Koninck.</i>	Limestone, Kildare. British Museum.
15, 16.	„ <i>Keyserlingianus, De Koninck.</i>	Limestone, Settle, Yorkshire.
17.	„ <i>arcuarius, De Koninck.</i>	Limestone, Settle, Yorkshire.
18.	„ <i>spinulosus, Sow.</i>	The original specimen. Linlithgowshire, Scotland, and collection of the late Dr. Fleming.
19.	„ „	From the Carboniferous limestone near Lesmahago, and collection of Dr. Slimon.
20.	„ <i>P. granulosus</i> , Phillips.	Carboniferous limestone, Settle, Yorkshire.
21.	„ „	Phillips's figure of <i>P. granulosus</i> .

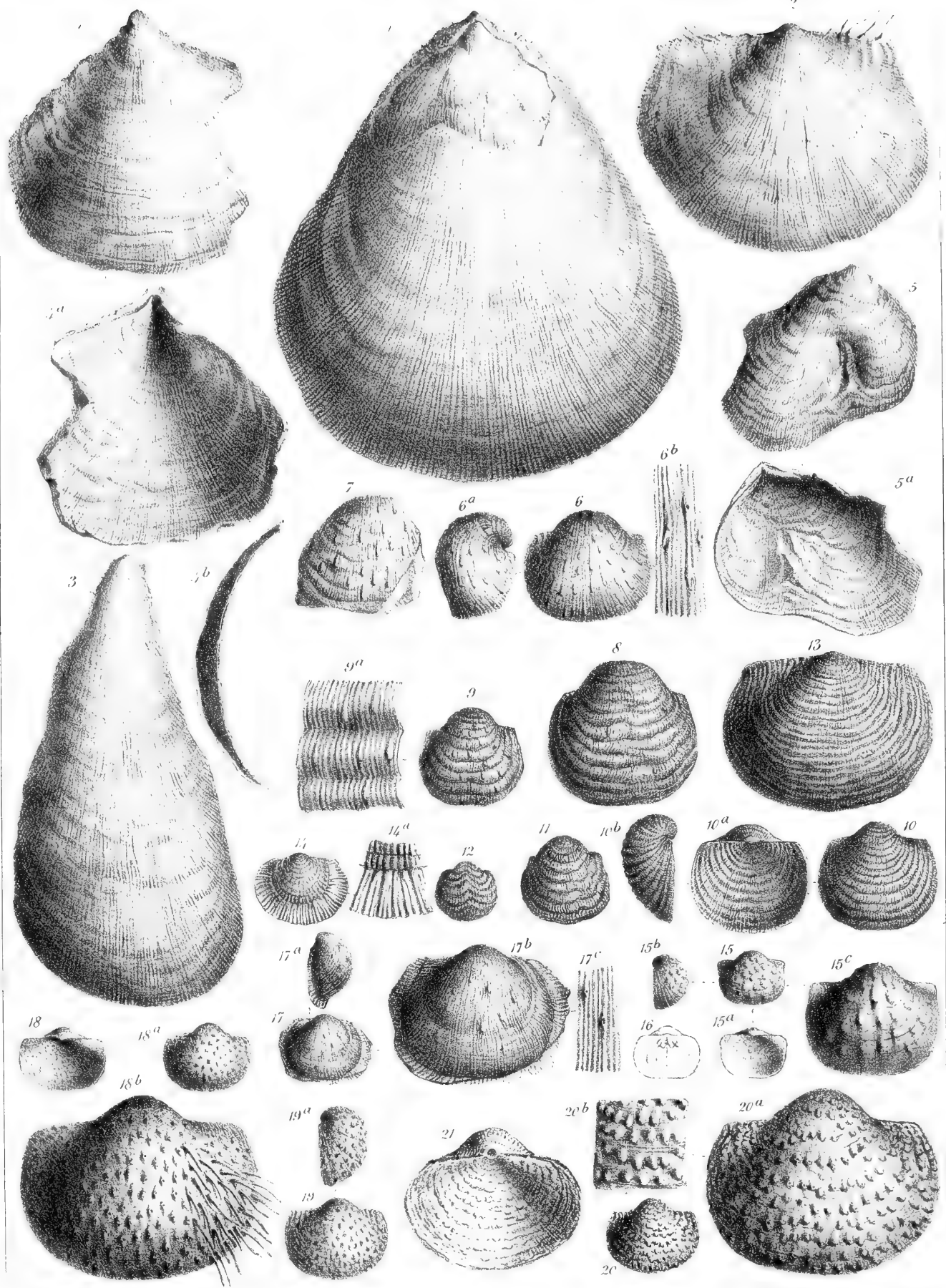


PLATE XXXV.

CARBONIFEROUS SPECIES.

- FIG.
1. *Productus latissimus*, Sow. Carboniferous limestone, Dalry, Ayrshire.
 2. " " " " " Derbyshire. Collection of Dr. Fleming, of Manchester.
 3. " " Interior of the dorsal valve, from near Carluke, in Lanarkshire.
 4. " " Interior of the ventral valve, from Broadstone, near Beith, Ayrshire, and collection of Mr. J. Armstrong.
 5. " *longispinus*, Sow. From the original example. West Lothian, and collection of the late Dr. Fleming.
 6. " " Ventral valve, with its elongated spines.
 7. " " From Yorkshire.
 8. " " From Craigie, near Kilmarnock, and collection of Mr. J. Thomson.
 9. " " 9^a. Interior of the ventral valve (enlarged); 9^b. interior of the dorsal valve. From the Carboniferous shales of Capelrig, Lanarkshire, Scotland.
 10. " " Interior of the dorsal valve. From shales under the main limestone, Campsie, Stirlingshire, and collection of Mr. J. Young.
 11. " " From East Kilbride, Lanarkshire.
 12. " " From the original example of *P. Flemingii*, Sow. West Lothian, Scotland.
 13. " " Specimens in Arenaceous limestone, from Rutcheugh, Northumberland.
 14. " " var. *P. lobatus*, Sow. From Capelrig, Lanarkshire.
 - 15, 16. " " var. *P. setosa*, Phillips. From the original figures in the 'Geology of Yorkshire.' These are certainly only different states of *P. longispinus*.
 17. " " var. *P. spinosus*, Sow. These figures are drawn and slightly restored from the original example in the collection of the late Dr. Fleming, Scotland.
 - 18, 19. " " Two exceptional shapes of *P. longispinus*, from Carboniferous shales near Carluke, in Lanarkshire.

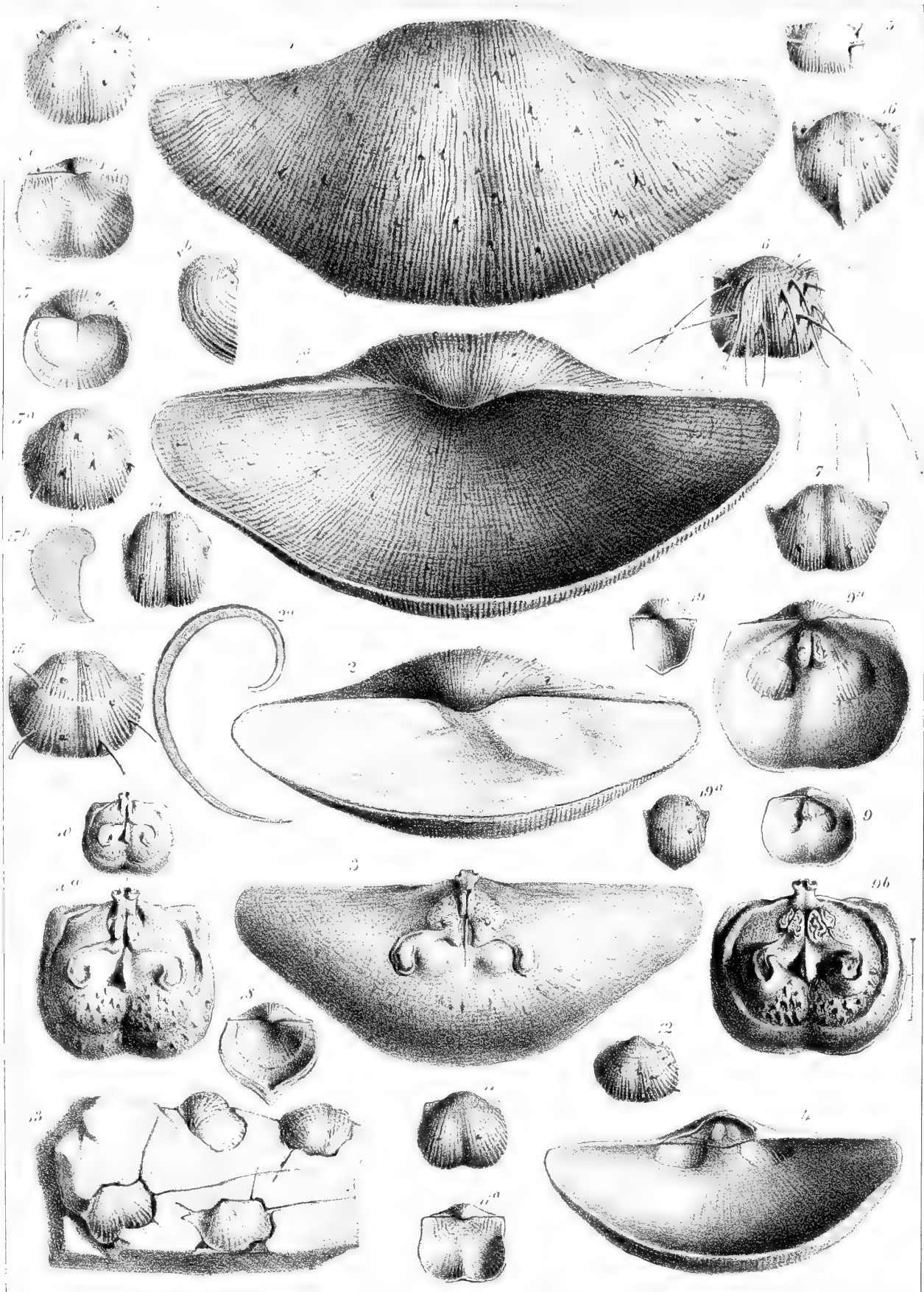
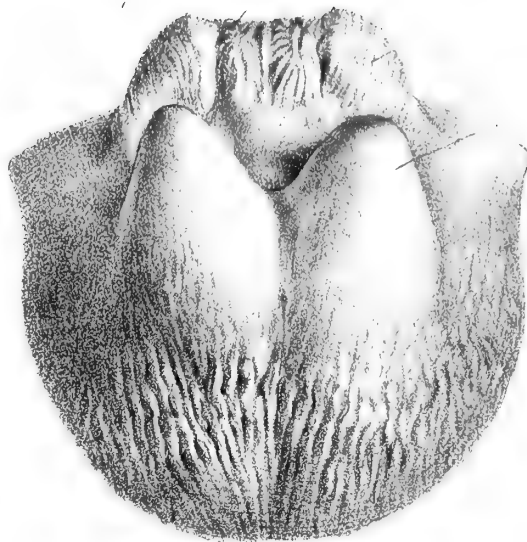
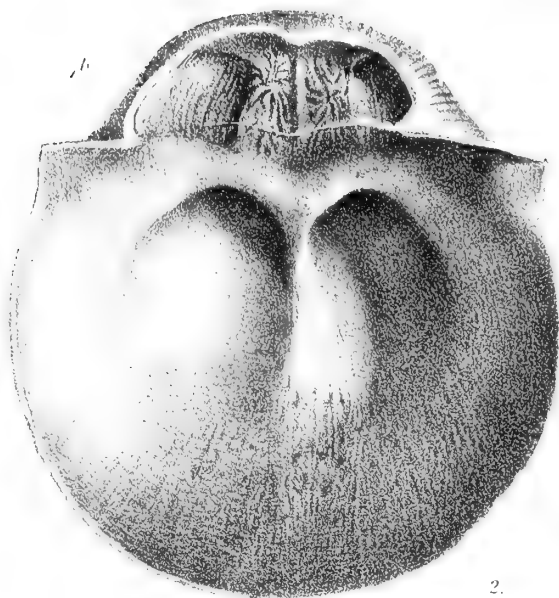


PLATE XXXVI.

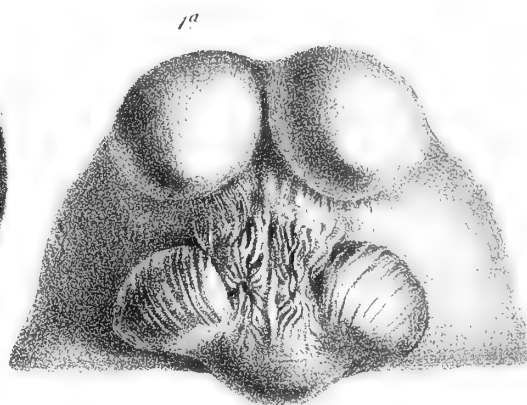
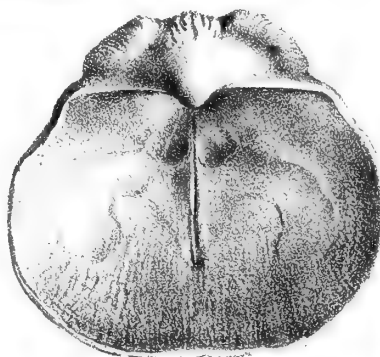
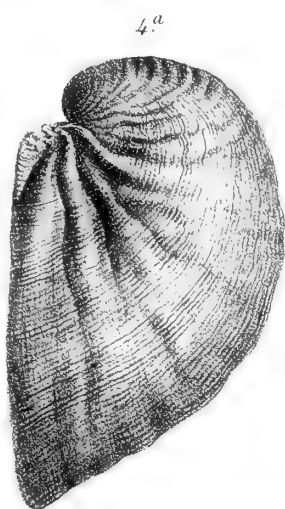
CARBONIFEROUS SPECIES.

FIG.

1. *Productus humerosus*, *Sow.* 1^a. Internal cast of the ventral valve, from the Carboniferous magnesian limestone of Breedon, Leicestershire. Museum of the Geological Society. 1^b. Interior of the ventral valve (a portion of the beak being removed to show the muscular impressions), from a gutta-percha impression.
2. " " Internal cast, from the same locality. 2 shows the interior of the dorsal valve and beak of ventral one; 2^a the ventral valve, viewed in profile.
3. " *personatus*, *Sow.* From the original internal cast. The specific claims of this so-termed species cannot be decided, on account of the imperfection of the material at our command. Kendal, Westmoreland. British Museum.
4. " *cora*, *D'Orbigny*. Carboniferous limestone, Settle, Yorkshire.

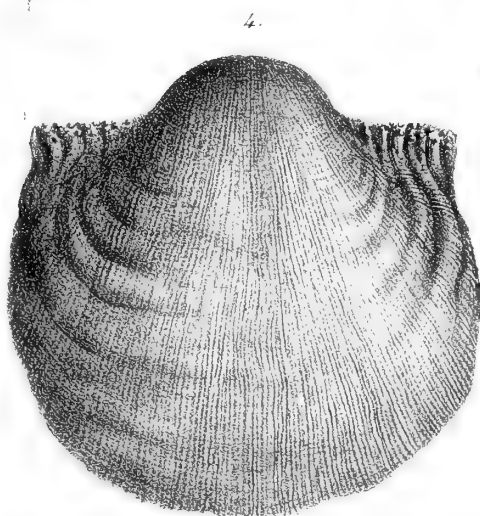


2.

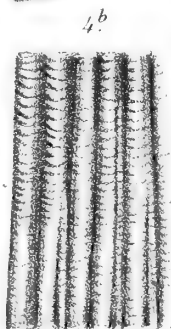


2^a

3.



4.



4^b

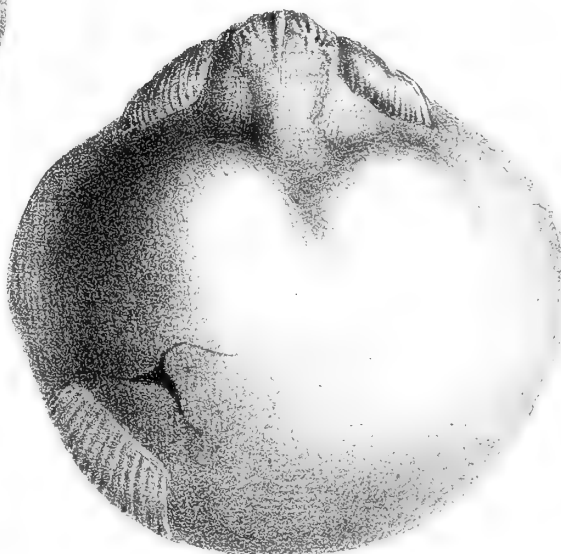


PLATE XXXVII.

CARBONIFEROUS SPECIES.

FIG.

1. *Productus giganteus*, *Martin*. Interior of the ventral valve, from which a portion of the beak has been removed, so as to exhibit the umbonal cavity. *A* and *c*, Adductor or *occluser*; *R*, cardinal or *divaricator*; muscular impressions; *L*, cavity occupied by the spiral arms.

2. „ „ Interior of the *dorsal valve*. *J*, Cardinal process; *A*, adductor or *occluser*, muscular impressions; *w*, projections to which Mr. S. P. Woodward supposes the oral arms to have been attached (?); *x*, reniform impressions; *z*, eminences corresponding to the hollows (*L*) in the ventral valve.

3. „ „ Hinge-line and cardinal process of dorsal valve.
 These drawings are taken from valves belonging to the same individual, which was obtained from the Carboniferous limestone Llangollen, and is in the Museum of Practical Geology. It is one of the most instructive specimens which I have hitherto examined. The cardinal process was, however, so much imbedded in the matrix that it could not be developed, so that the deficiency was completed from another example in the British Museum.

4. „ „ Ideal section or both valves (slightly improved) from the figure published by Mr. S. P. Woodward, at p. 233 of his 'Manual of the Mollusca.' The letters refer to the same parts in the other specimens.

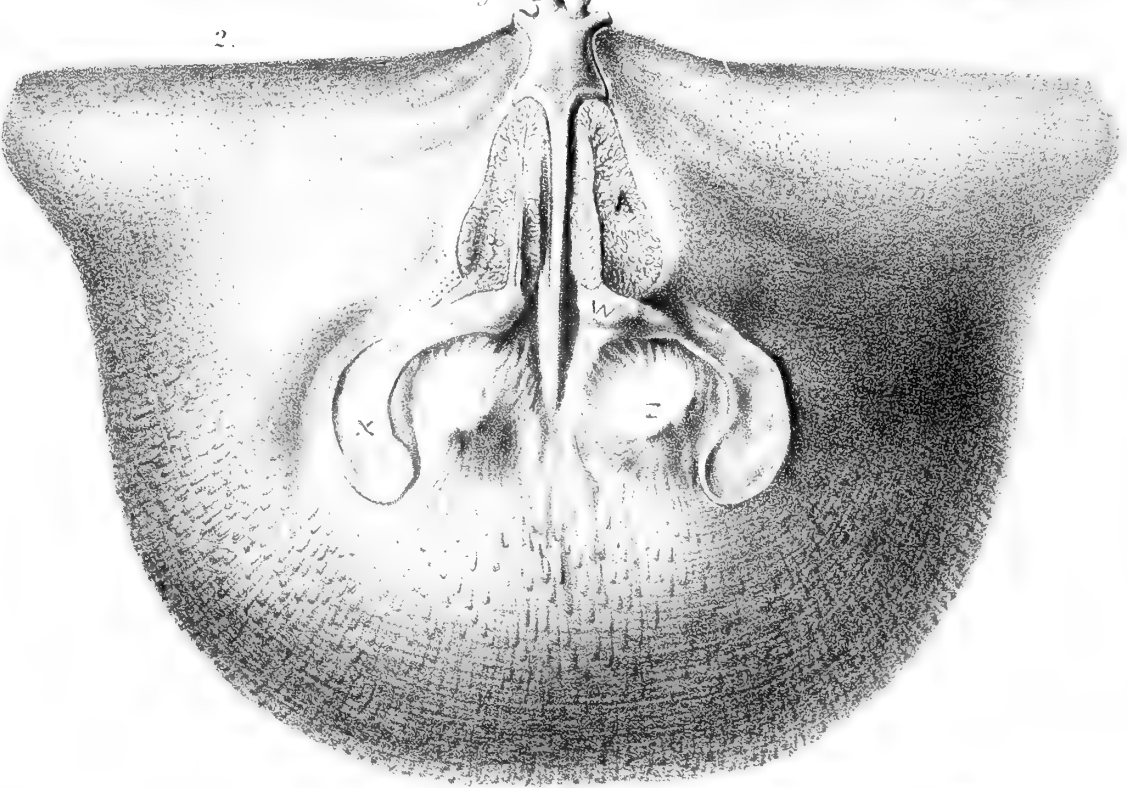
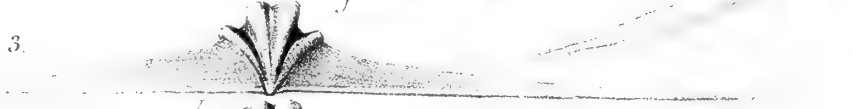
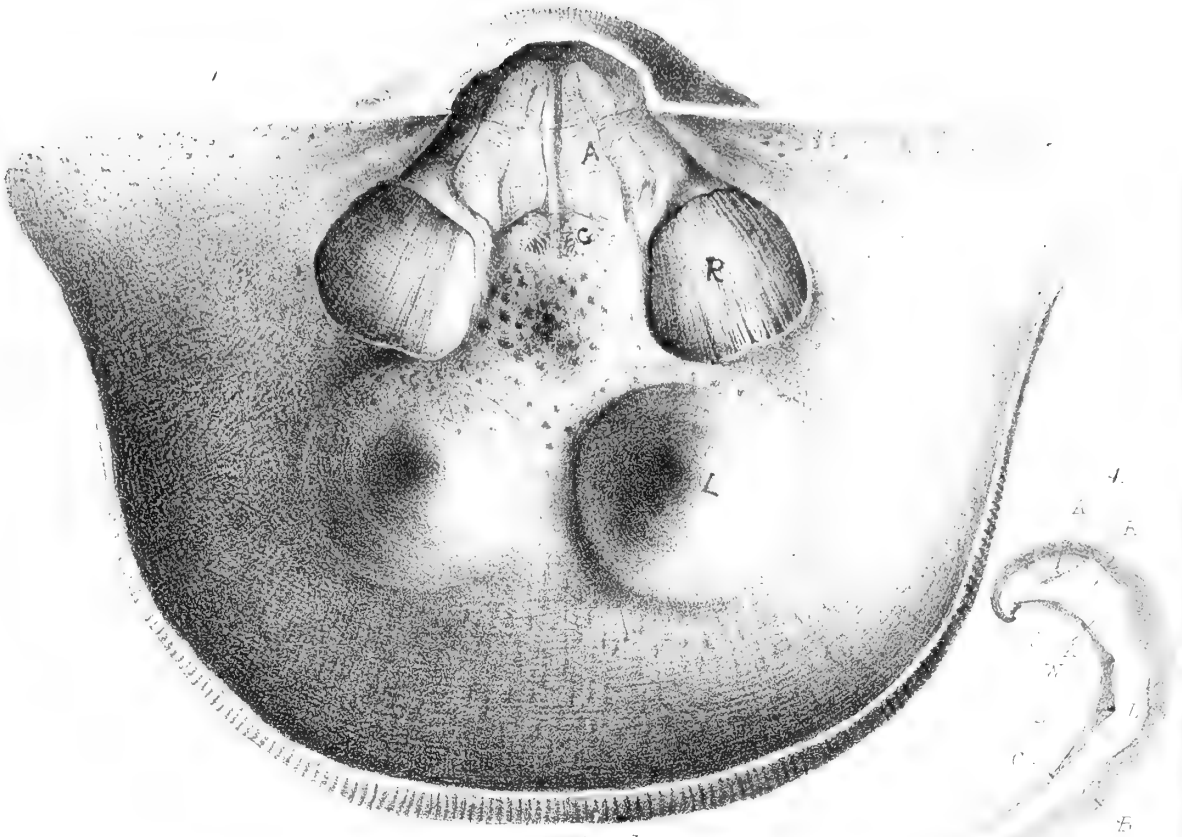


PLATE XXXVIII.

CARBONIFEROUS SPECIES.

Productus giganteus, *Martin*. A very large example, from the Carboniferous limestone of Derbyshire, in the collection of Prof. Tennant.

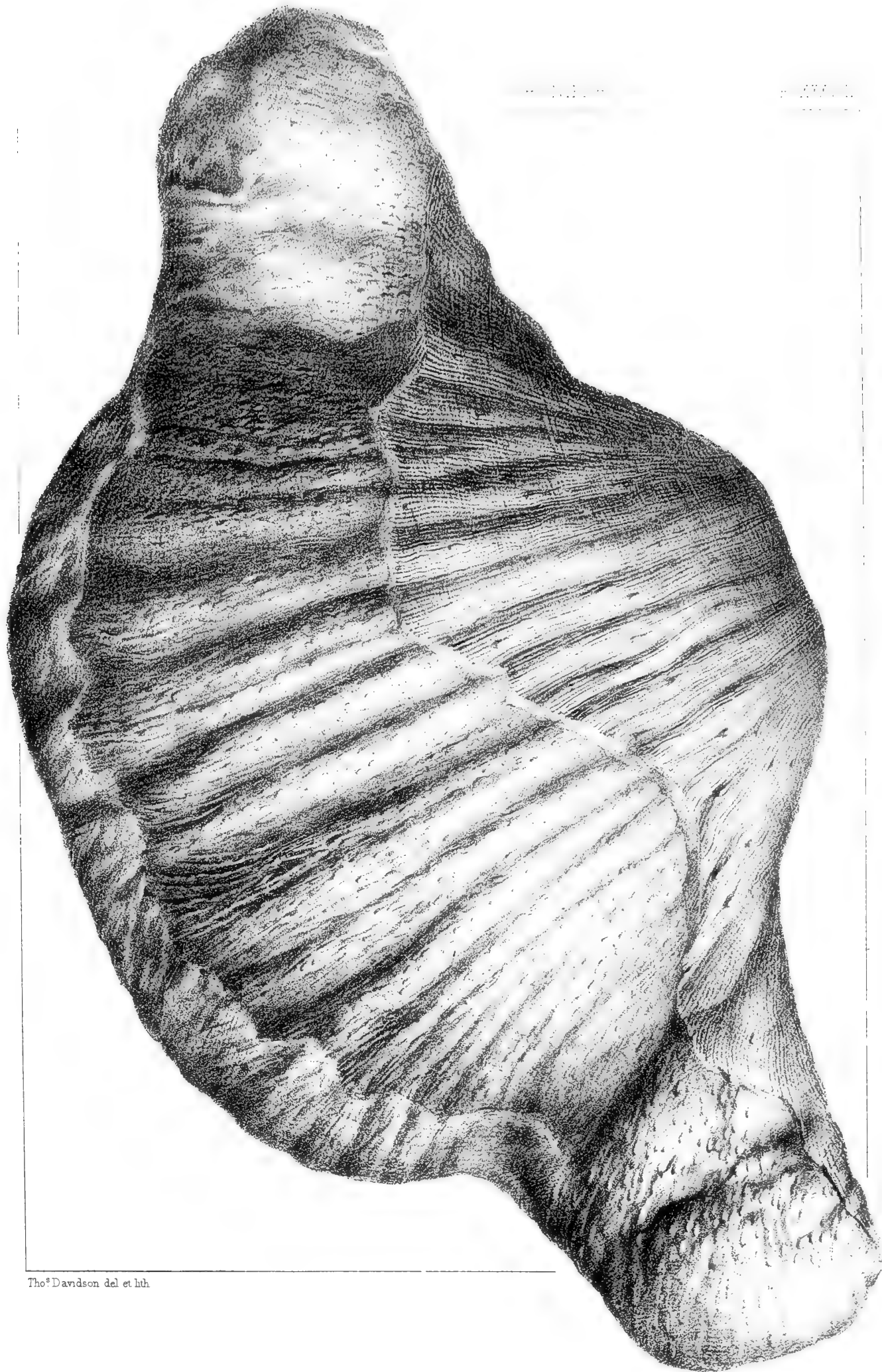
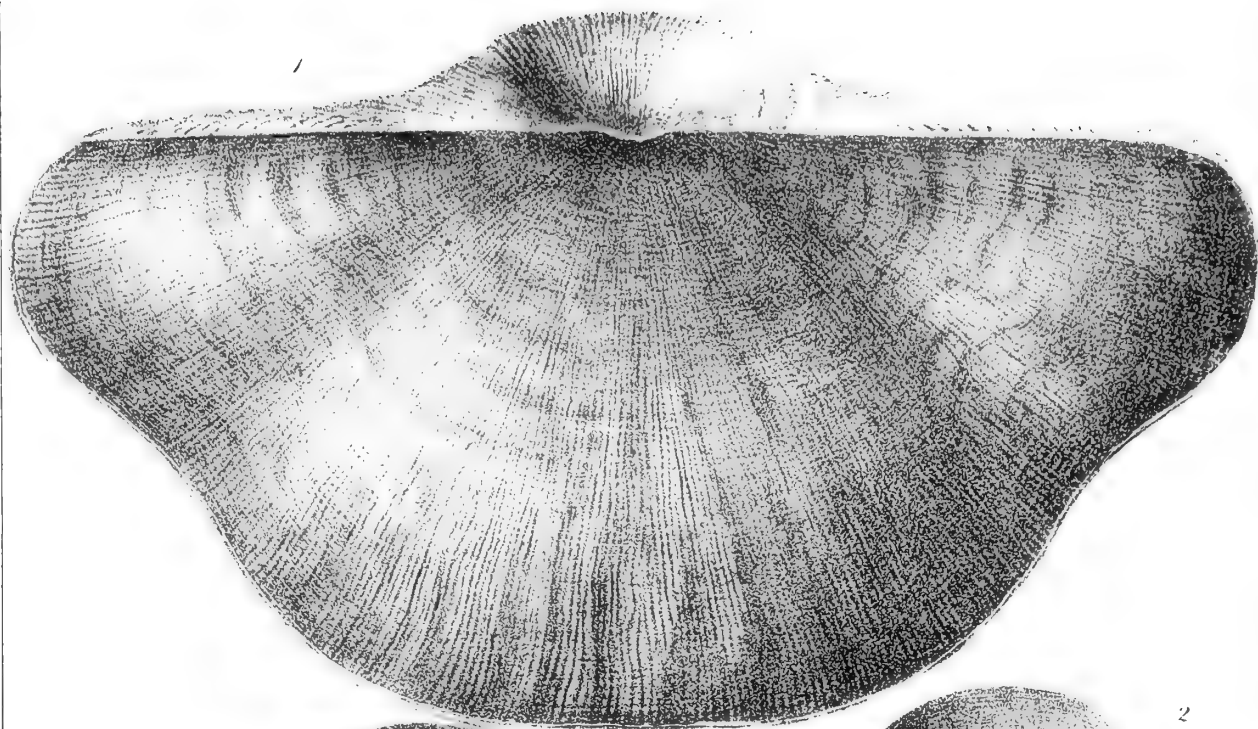


PLATE XXXIX.

CARBONIFEROUS SPECIES.

FIG.

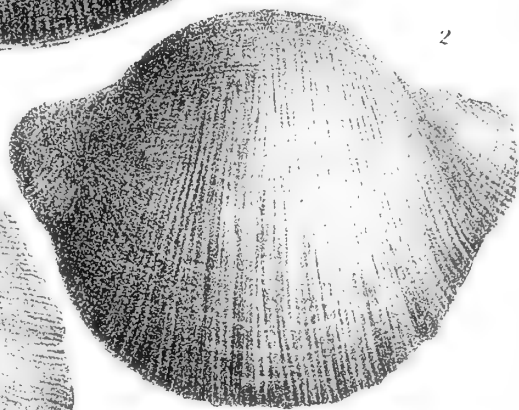
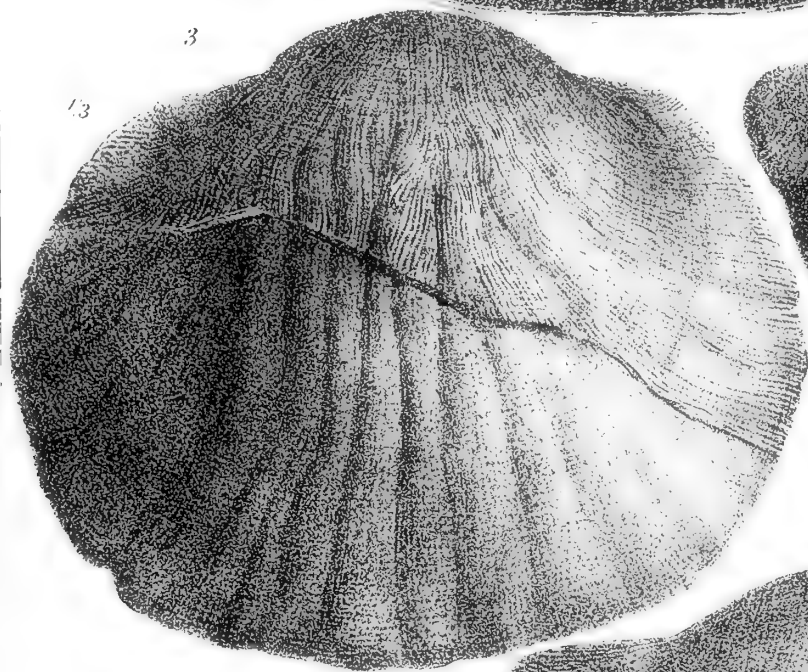
1. *Productus giganteus*, *Martin*. Dorsal valve and beak of ventral one. Carboniferous limestone near Richmond, Yorkshire, and collection of Mr. E. Wood.
2. „ „ A smaller specimen. Same locality.
3. „ „ A very circular variety.
4. „ „ An evenly convex variety, *P. maximus*, M'Coy. Carboniferous limestone near Cork, Ireland.
5. „ „ A young example. Yorkshire.



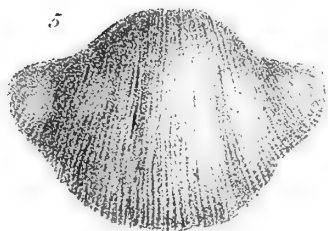
3

2

43



5



1

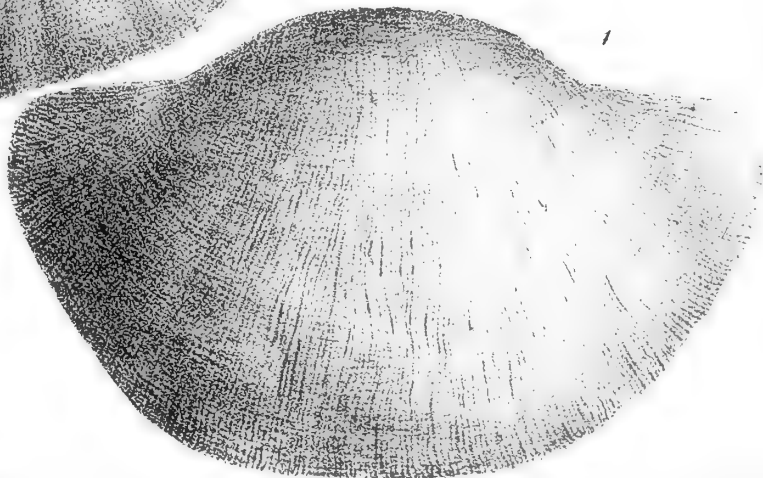




PLATE XL.

CARBONIFEROUS SPECIES.

FIG.

- | | | |
|---------|--------------------------------------|--|
| 1. | Productus giganteus, <i>Martin</i> . | Internal cast of the ventral valve, from the Carboniferous limestone of Lowick, Northumberland, and from the same specimen which was represented under another aspect in Professor King's 'Permian Monograph.' The letters are the same which have been made use of in the interior, Pl. XXXVII, fig. 1. |
| 2. | ,, ,, | var. <i>P. Edelburgensis</i> , Phillips. From a specimen in the Carboniferous limestone of Yorkshire. |
| 3. | ,, ,, | A decorticated specimen or cast, from the Carboniferous limestone of Thornton, Wensleydale, showing a peculiar interruption and bifurcation of ribs. |
| 4 to 8. | ,, ,, | var. ? <i>P. hemisphæricus</i> , Sow. From the Carboniferous limestone of Craven, in Yorkshire, where the shell occurs by millions. |
| 9. | ,, ,, | From one of the original and typical specimens of <i>P. hemisphæricus</i> , Sow., from the mountain limestone of Mynidd Craig, near Kidwelly, in Carmarthenshire. |

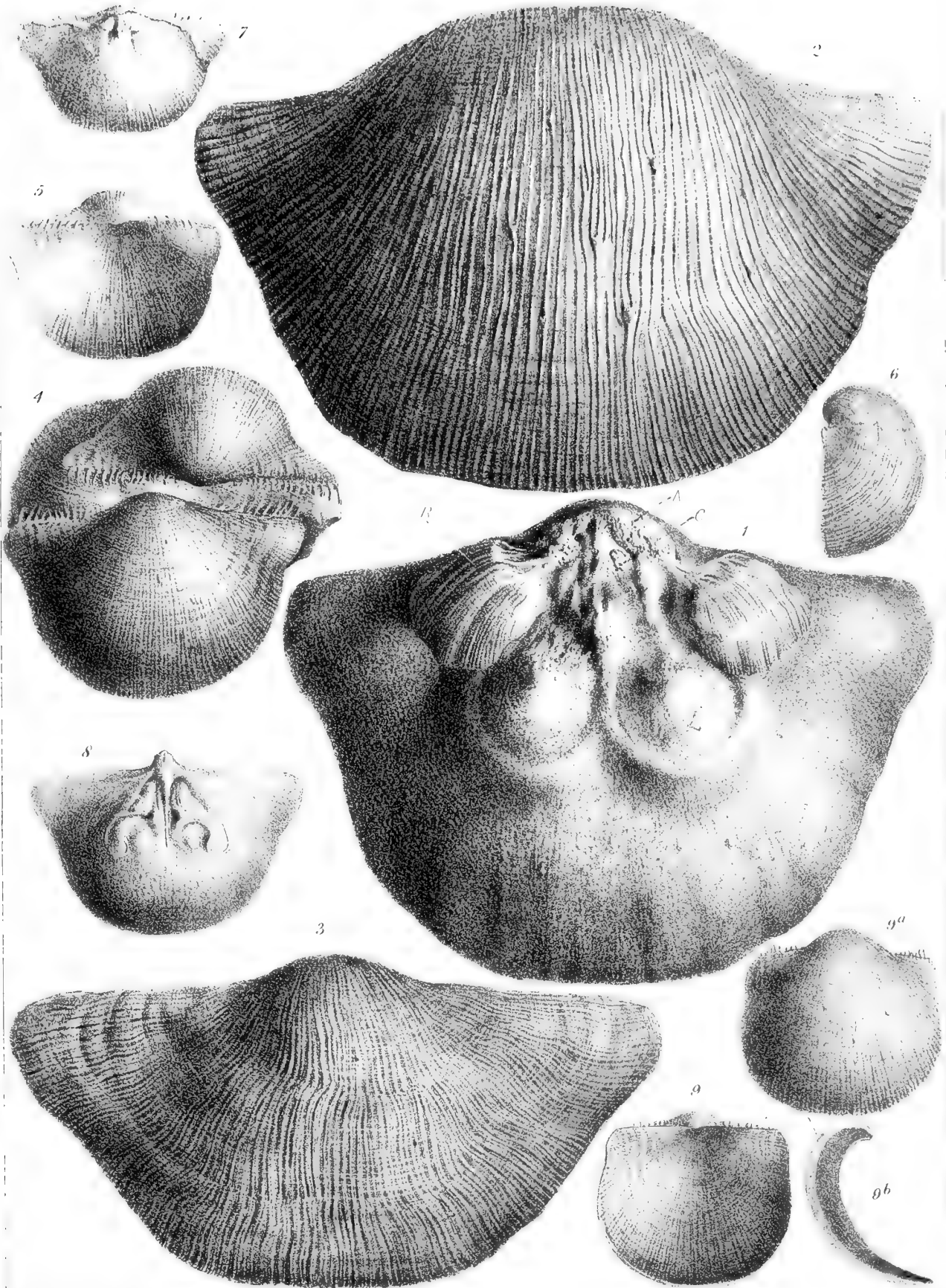


PLATE XLI.

CARBONIFEROUS SPECIES.

FIG.

- | | | | | |
|----|-----------|-------------|-------------------|--|
| 1. | Productus | pustulosus, | <i>Phillips</i> . | The original specimen, from the mountain limestone of Bolland. Gilbertson's collection. British Museum. |
| 2. | „ | „ | | A very large example, from the Carboniferous limestone of Derbyshire. Museum of Practical Geology. |
| 3. | „ | „ | | From the Carboniferous limestone of Craven. Collection of Mr. E. Wood. |
| 4. | „ | „ | | Interior of the dorsal valve, from the Carboniferous limestone of Yorkshire. |
| 5. | „ | „ | | Internal cast of the ventral valve, seen from the umbonal portion. Shores of Lough Gill, County Sligo. Museum of the Geological Society. |
| 6. | „ | „ | | This is the <i>P. rugata</i> of Phillips, not well represented in the 'Geology of Yorkshire.' Bolland. |

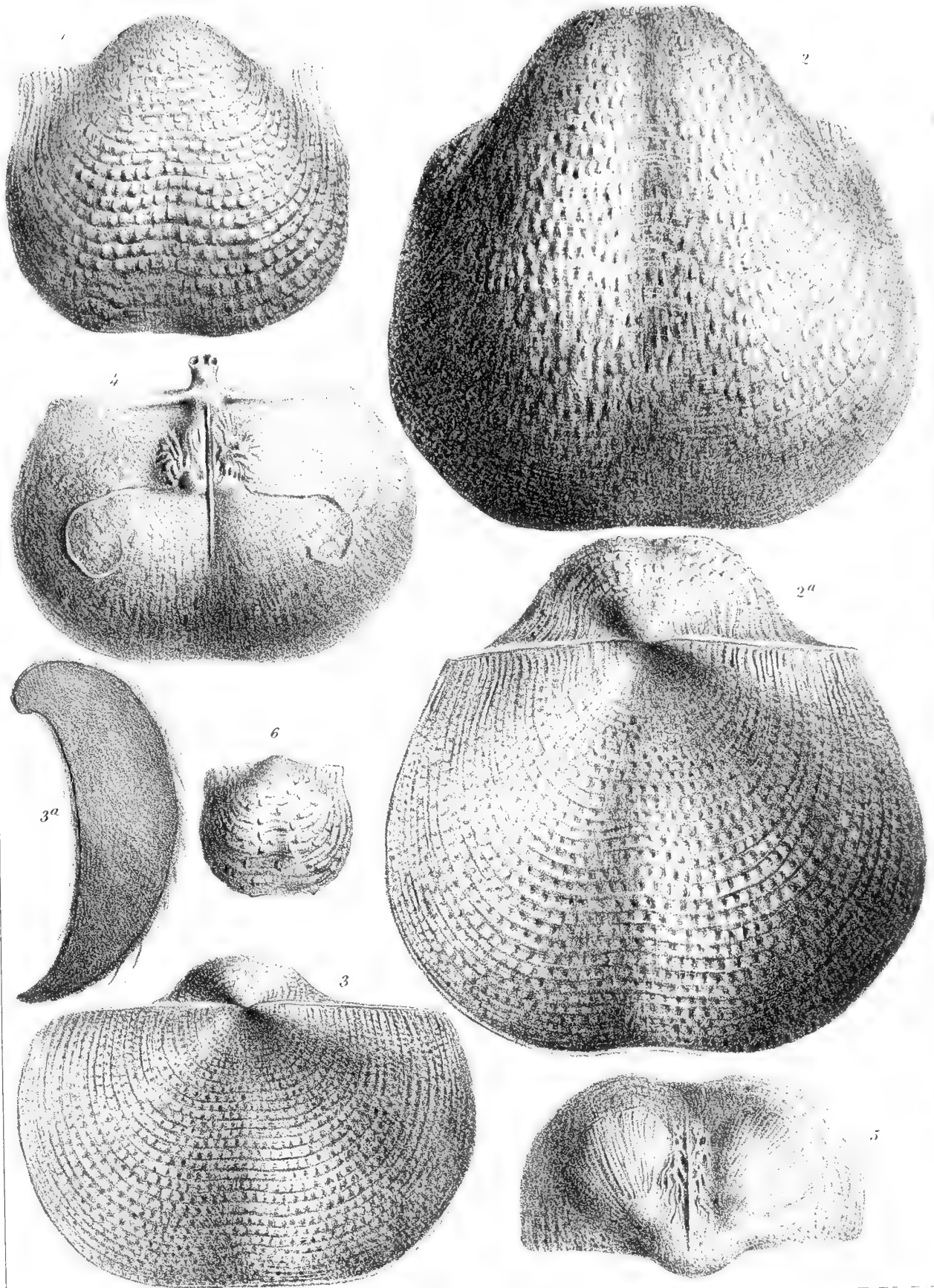


PLATE XLII.

CARBONIFEROUS SPECIES.

FIG.

- | | | |
|---------------------|---|---|
| 1, 2. | Productus pustulosus, <i>Phillips</i> . | From the Carboniferous limestone of Kildare, in Ireland. |
| 3. | „ „ | <i>P. ovalis</i> , Phillips, from the Carboniferous limestone of Bolland. |
| 4. | „ „ | <i>P. pyxidiformis</i> , De Koninck, from the Carboniferous limestone of Yorkshire. |
| 5. | „ scabriculus, <i>Martin</i> . | From the Carboniferous limestone of Carlisle, Lanarkshire, Scotland. |
| 6. | „ „ | <i>P. quincuncialis</i> , Phillips. Carboniferous limestone of Yorkshire. |
| 7. | „ „ | A very large example from the Craven district, in Yorkshire, and collection of Mr. E. Wood. |
| 8, 8 ^a . | „ „ | Interior of the dorsal valve, showing the curiously divided median ridge, from the Carboniferous shales of Lanarkshire, Scotland. |
| 9. | „ cora, <i>D'Orbigny</i> . | From a specimen showing the concentric wrinkles sometimes present in the dorsal valve. Derbyshire? |

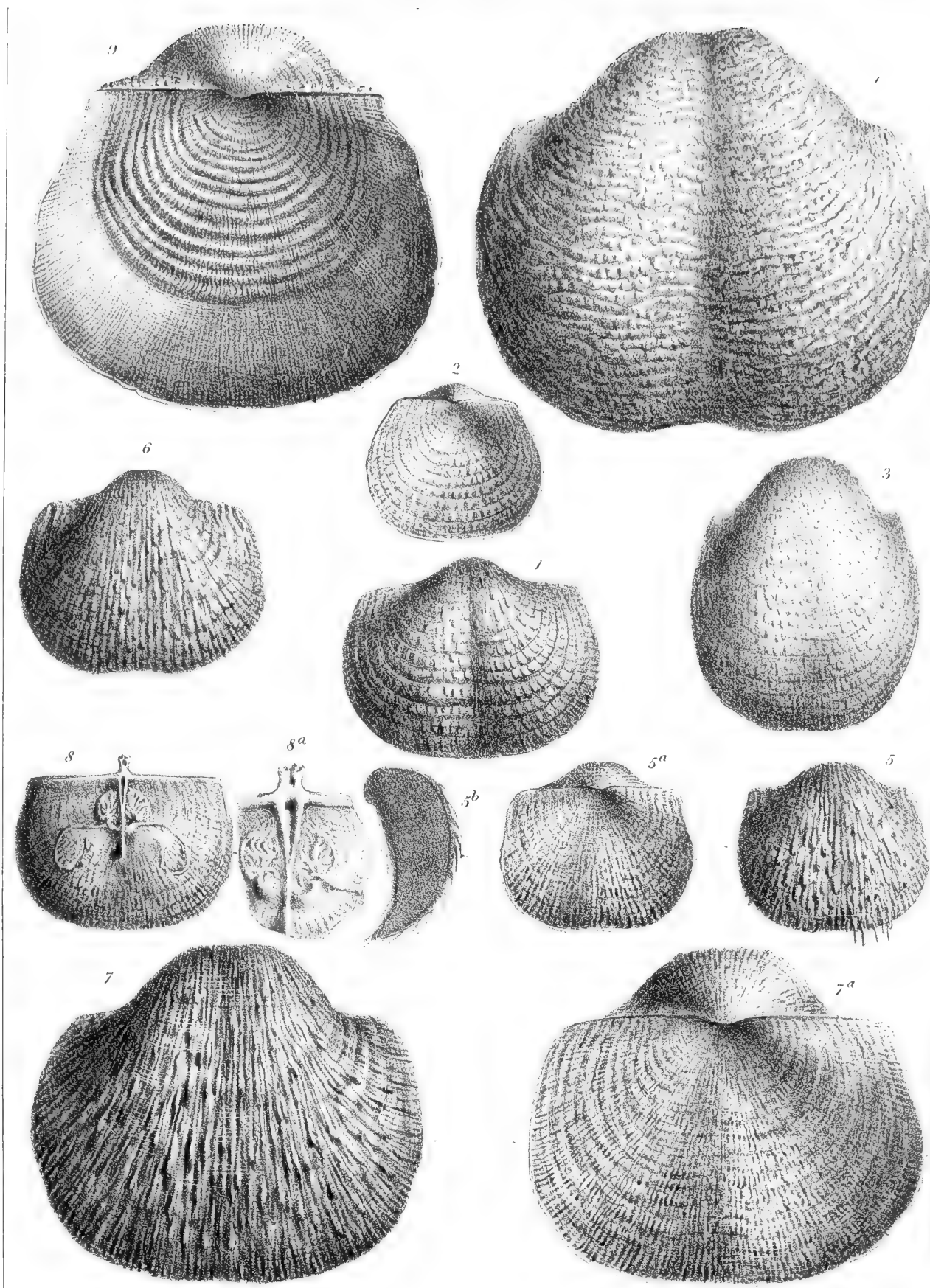


PLATE XLIII.

CARBONIFEROUS SPECIES.

FIG.

1. *Productus semireticulatus* *Martin*. From the Carboniferous limestone of Kildare.
1^a. A large spine.
2. " " A specimen agreeing with Phillips's *P. pugilis*, from the
Carboniferous limestone of Stirlingshire.
- 2^o. " " From the Carboniferous limestone of Nellfield, Lanark-
shire.
3. * " " Portion of a ventral valve, showing a long spine *in situ*.
Limestone, Kildare, Ireland, and Museum of Practical
Geology.
4. " " Profile of a specimen from Kildare.
5. " " Portion of a specimen (enlarged), in which a small,
but distinct, area and a pseudo-deltidium can be
perceived. Locality unknown, probably Derbyshire.
British Museum.
6. " " var. *Martini*, Sow. Carboniferous limestone, Settle,
Yorkshire.
7. " " " From Park Hill, Longnor, Derby-
shire, and Museum of Practical
Geology.
8. " " " Interior of dorsal valve, from
shales near Settle, in Yorkshire.
9. " " var. *concinna*, Sow. From the Carboniferous limestone of
Campsie, Stirlingshire.
10. " " " A specimen of the same, to show
how the shell becomes at times
fractured.

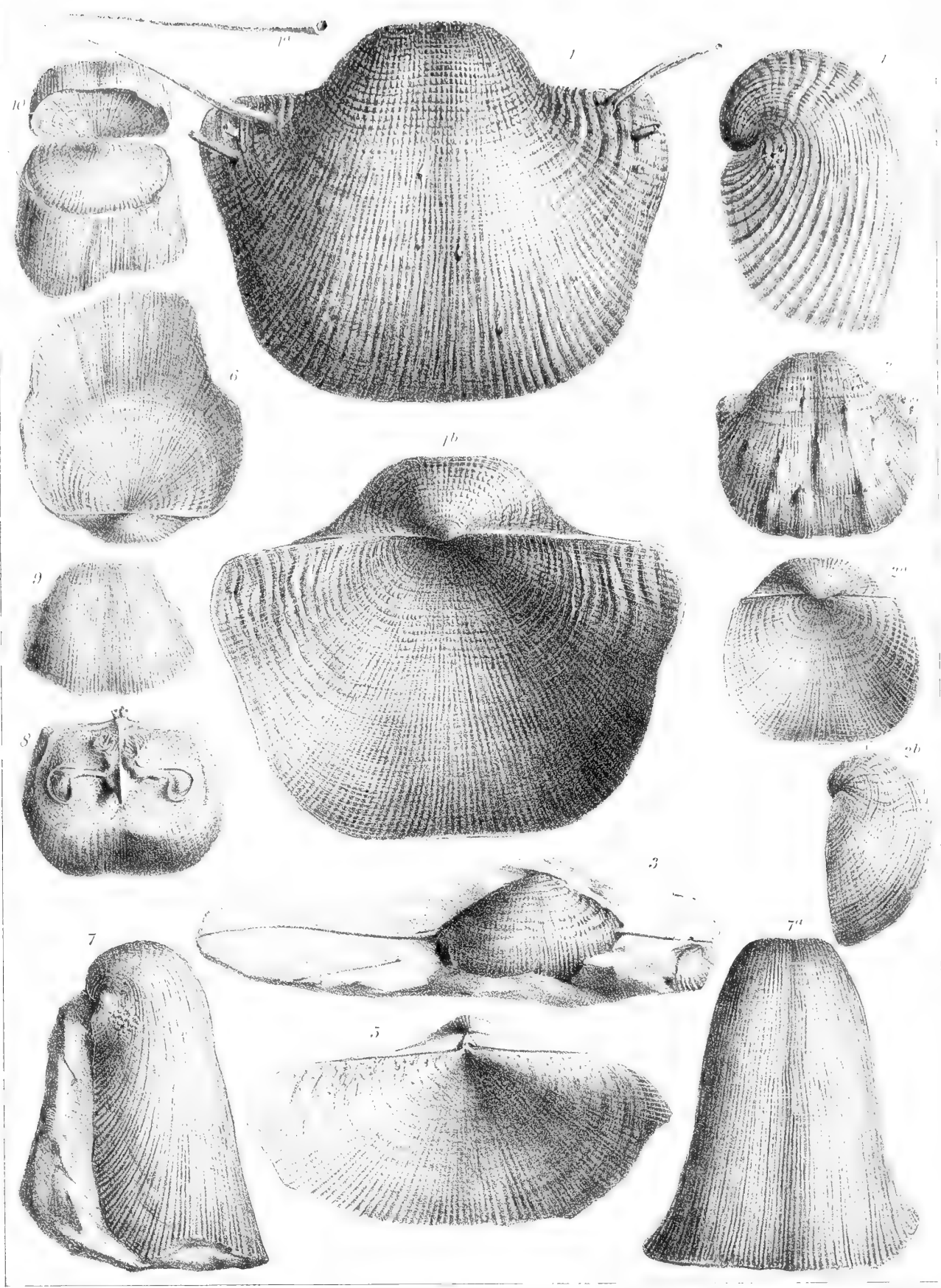


PLATE XLIV.

CARBONIFEROUS SPECIES.

FIG.

1. *Productus semireticulatus*, *Martin*. Interior of the dorsal valve, from the Carboniferous shales of Calderside, E. Kilbride, Scotland.
2. „ „ Enlarged fragment of another specimen, from Redesdale, Northumberland.
3. „ „ Fragments (enlarged) to show the cardinal process, as seen from the exterior of dorsal valve.
4. „ „ Interior of the ventral valve, from Calderside, E. Kilbride, Lanarkshire, Scotland. Beautifully preserved interiors of both valves occur in a shale near Settle, in Yorkshire.
5. „ *margaritaceus*, *Phillips*. From the Carboniferous limestone of Settle, in Yorkshire.
6. „ „ The typical specimen, from Florence Court, and collection of Prof. Phillips.
7. „ „ A young shell, from Settle.
8. „ „ Phillips's *P. pectinoides*. Carboniferous limestone, Bolland, Yorkshire.
9. „ *punctatus*, *Martin*. From the Carboniferous limestone of Wensleydale, Yorkshire.
10. „ „ From the limestone of Ayrshire, Scotland. 10^b Spiny surface, enlarged.
11. „ „ From Settle, Yorkshire.
12. „ „ A very elongated example, from the limestone of West Broadstone, Ayrshire, Scotland.
13. „ „ A young shell, from Bolland.
14. „ „ An oval variation, from Wensleydale, Yorkshire.
15. „ „ var. *elegans*, M'Coy. Carboniferous shales of Craigen-glen, Stirlingshire.
16. „ „ Interior of the dorsal valve, from shales near Settle, Yorkshire.
17. „ „ Internal cast of the ventral valve, as seen from the beak.
18. „ *fimbricatus*? var. *laciniatus*, M'Coy. From the Carboniferous limestone of Kendal, in Westmoreland.

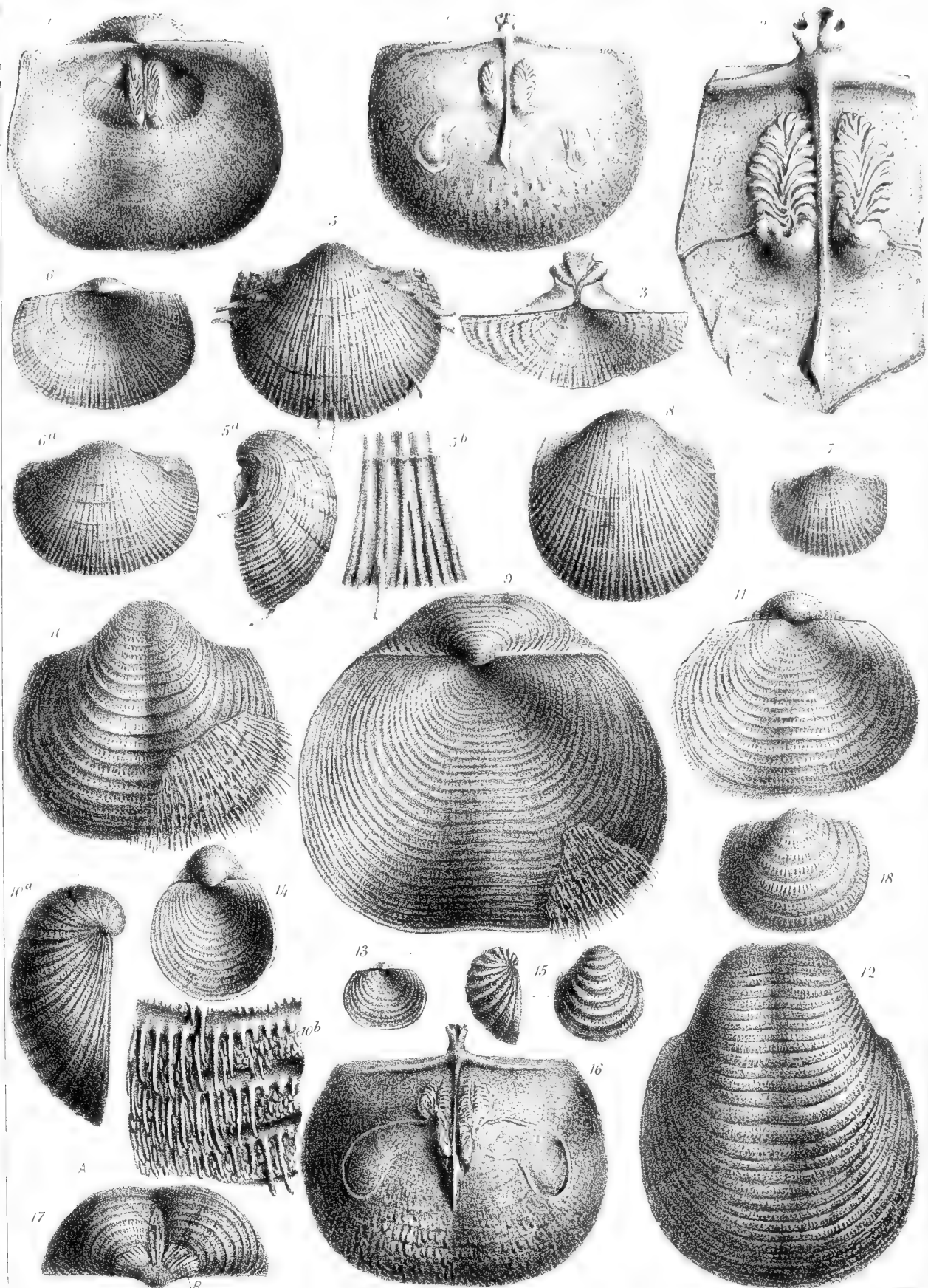


PLATE XLV.

CARBONIFEROUS SPECIES.

- | | | | |
|-------|------------------------------|-----------------------|--|
| FIG. | | | |
| 1, 2. | Chonetes ? comoides ? | <i>Sowerby.</i> | From the Carboniferous limestone, Trefonen, south-west of Oswestry. In the collection of Mr. G. W. Ormerod, of Manchester. |
| 3, 4. | „ | „ | Interior of ventral valve, showing the strong, articulating teeth, from Llanymynech. Same collection. |
| 5, 6. | „ | „ | Longitudinal section and weathered specimen, from Tidenham Chase (Gloucestershire), near Chepstow. |
| 7. | „ | comoides, Sow. | A characteristic example, locality lost. Bristol Museum. |

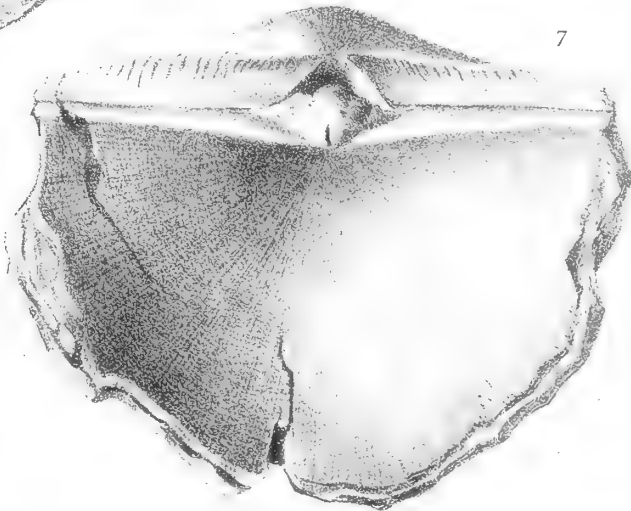
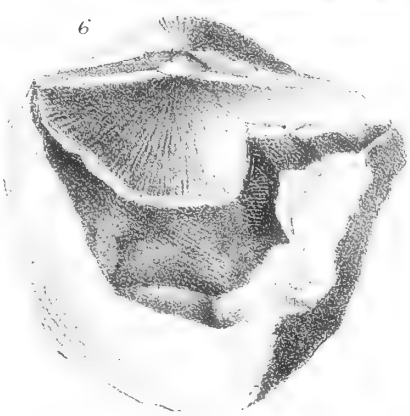
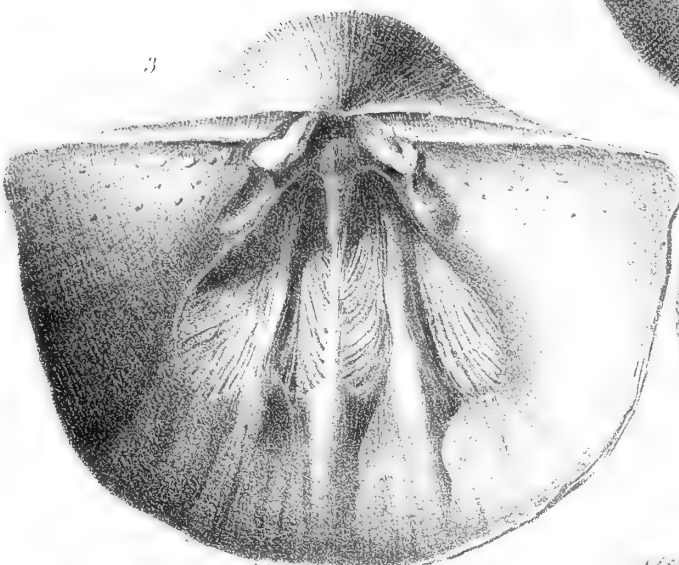
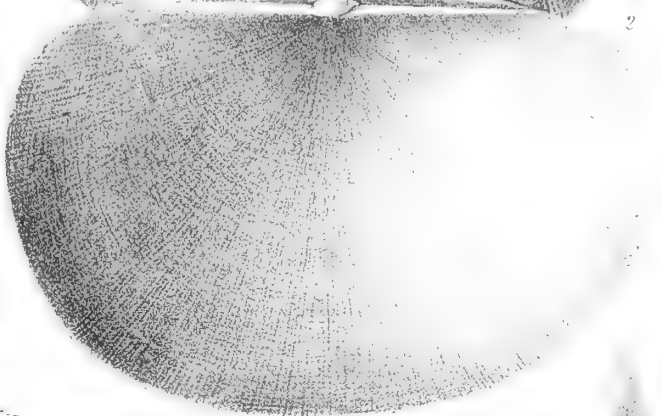
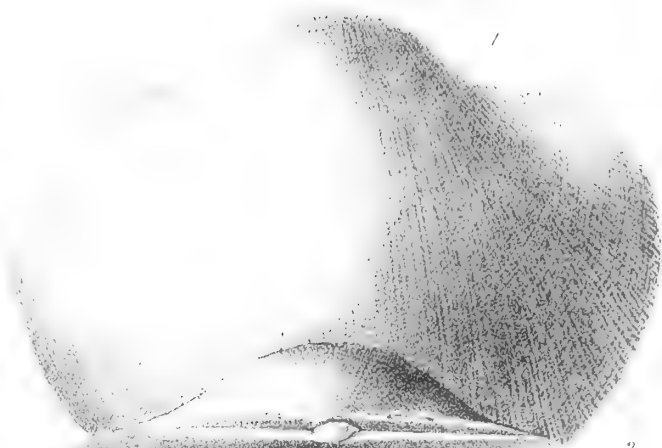
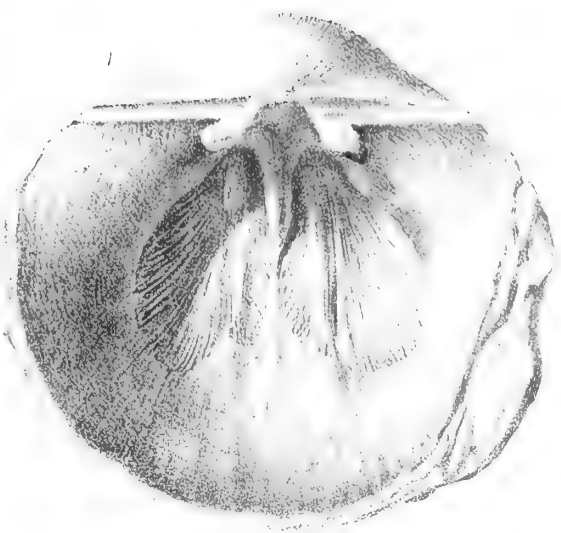


PLATE XLVI.

CARBONIFEROUS SPECIES.

- FIG.
1, 2. *Chonetes comoides*? *Sow.* From the Carboniferous limestone of Bundoran, in Donegal, and collection of the Geological Society.
- 3, 4. „ *papilionacea*, *Phillips.* From Phillips's original example. Carboniferous limestone, Bolland. A portion of one wing has been restored.
5. „ „ From Carboniferous shales near Settle, in Yorkshire.
5^b. A portion of the shell enlarged; o, orifices left by the broken spines; p are pits left on the cast by the asperities which covered the inner surface of the shell.
6. „ „ Internal cast, showing traces of the muscular impressions, from Ireland.
7. „ *Dalmaniana*, *De Koninck.* From the Carboniferous limestone of Settle, in Yorkshire.

CARBONIFEROUS.

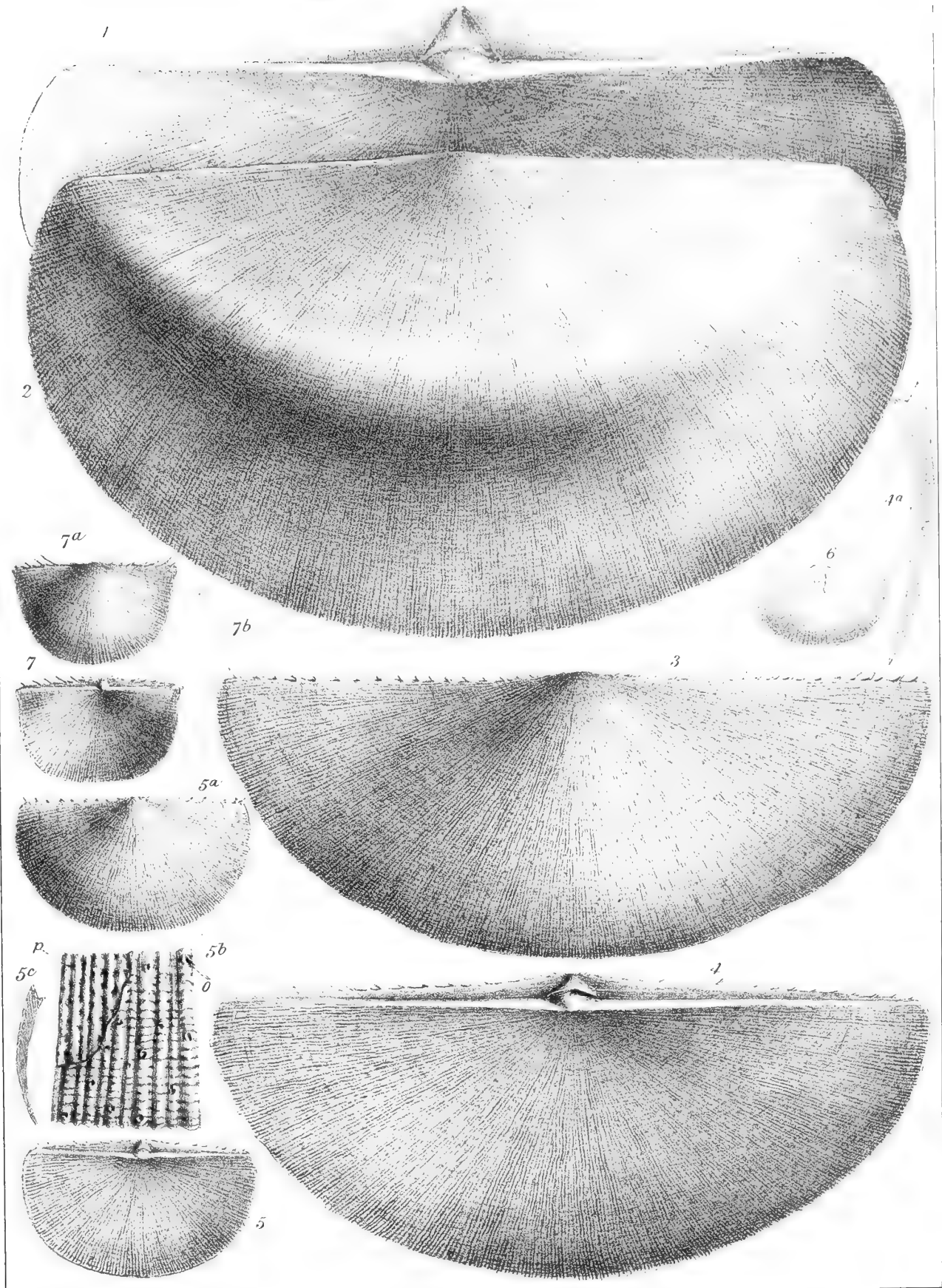


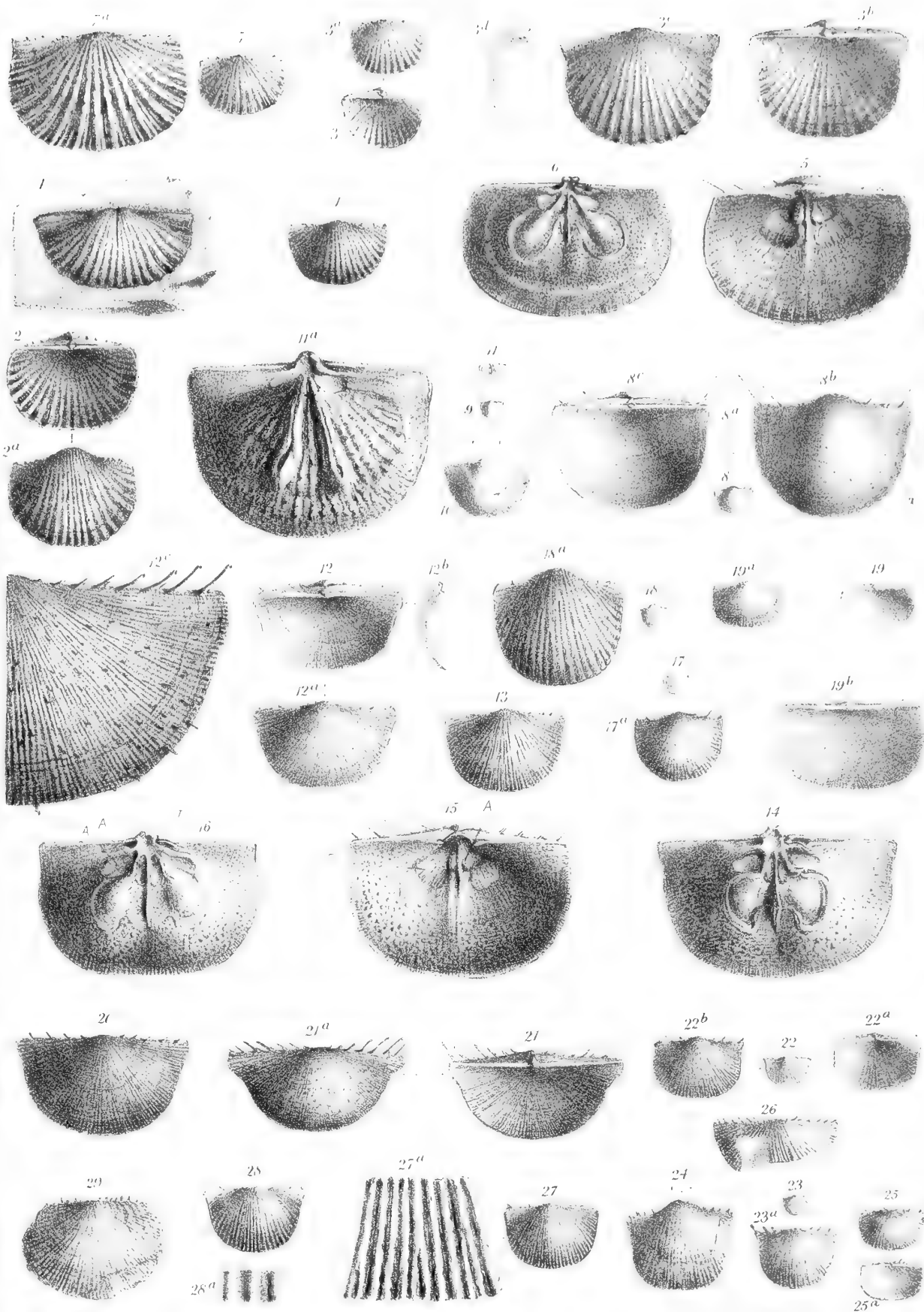
PLATE XLVII.

CARBONIFEROUS SPECIES.

- FIG.
1. Chonetes Buchiana, *De Koninck*. From the Carboniferous limestone of Settle, in Yorkshire.
 2. " " Variety with strong ribs, from the Carboniferous shales of Malham Moor.
 3. " " From Gare, Lanarkshire, Scotland. 3^{b, c, d}. Enlarged.
 4. " " A very large and transverse example. Rutcheugh, Northumberland.
 - 5, 6. " " Interior of the ventral and dorsal valves, enlarged, from specimens found at Malham Moor by Mr. Burrow.
 7. " " var. *interstriata*. From the Carboniferous limestone of Settle, discovered by Mr. Burrow. 7^a. Enlarged.
 8. " *polita*, *M'Coy*. From the Carboniferous shales of Craigenglen, Stirlingshire, in Scotland, and collection of Mr. J. Young. 8^{b, c}. Enlarged.
 9. " " Another example, from the same locality.
 10. " " Prof. M'Coy's original figure.
 11. " " Interior of the dorsal valve, from the Craigenglen beds, Stirlingshire, Scotland.
 12. " *Hardrensis*, *Phillips*. A typical example, from the Carboniferous shales of East Barns, near Dunbar, in Scotland. 12^c. Half of one of the valves, carefully enlarged.
 13. " " A more coarsely striated variety, from Settle, in Yorkshire.
 14. " " Interior of the dorsal valve, enlarged, from the Carboniferous shales of Calderside, Lanarkshire, Scotland, and collection of Mr. J. Thomson.
 15. " " Interior of the ventral valve, enlarged, from Capelrig, in Lanarkshire.
 16. " " Interior of the dorsal valve, corresponding to fig. 15. Same locality, and collection of Mr. J. Armstrong.
 17. " " A young specimen, from Craigie, near Kilmarnock. Collection of Mr. J. Thomson. 17^a. Enlarged.
 18. " " A small specimen, from Settle. 18^a. Enlarged.
 19. " " var. *laguessiana*, *De Koninck*? From the Carboniferous shales of Newton-on-the-More, Northumberland. 19^a. Enlarged.

FIG.

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|-----|-----------------------------|------------------------------|---|
| 20. | Chonetes Hardrensis. | <i>C. sulcata</i> , M'Coy. | From the original specimen, Arenaceous slate, Bruckless, Dunkeneely, Ireland. Collection of Sir R. Griffith. |
| 21. | „ „ | <i>C. volva</i> , M'Coy. | From the original and other examples in the collection of Sir R. Griffith, Carboniferous limestone of Millecent, Ireland. |
| 22. | „ „ | | A small variety, from the shales above the Hosie limestone, South Hill, Campsie, Stirlingshire, Scotland. |
| 23. | „ „ | <i>C. gibberula</i> , M'Coy. | From the original figure. |
| 24. | „ „ | <i>C. subminima</i> , M'Coy. | From the original figure. |
| 25. | „ „ | <i>C. perlata</i> , M'Coy. | From the original specimen, in the collection of Sir R. Griffith. |
| 26. | „ serrata, | <i>M'Coy</i> . | From the original specimen, Carboniferous limestone, Millecent, Ireland. |
| 27. | „ tuberculata, | <i>M'Coy</i> . | From the original specimen, Carboniferous limestone, Millecent, Ireland. |
| 28. | „ Buchiana? or crassistria, | <i>M'Coy</i> . | From the original specimen, Bundoran, Ireland. |
| 29. | „ papyracea, | <i>M'Coy</i> . | From the original specimen, Ireland. |





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MONOGRAPHS
ON THE
BRITISH FOSSIL
REPTILIA

FROM
THE OOLITIC FORMATIONS.

BY
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PART FIRST,
CONTAINING
SCELIDOSAURUS HARRISONII AND PLIOSAURUS GRANDIS.

LONDON:
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A MONOGRAPH
OF A
FOSSIL DINOSAUR
(*SCOLIDOSAURUS HARRISONII*, OWEN)
OF THE
LOWER LIAS.

IN the year 1858 a few fragmentary fossils of limb-bones were submitted to my inspection by James Harrison, Esq., of Charmouth, Dorsetshire, obtained from the upper part of the "lower Lias," near that place. They included portions of a femur and of a tibia, in which the texture of the wall and the size of the cavity of the shaft showed them to have been parts of a Saurian of more terrestrial habits than any of those which had been previously discovered in Liassic deposits: traces, moreover, of the extent and direction of certain processes, although broken away in the fossils, were discernible, which led me to suspect they belonged to a reptile allied to *Iguanodon*. I therefore briefly notified the fact of a Liassic Dinosaur in my 'Palæontology,'* and indicated the animal by the generic name *Scelidosaurus*.† I propose, in the present monograph, to describe these very interesting fossils as they have successively come under my observation, and submit the proofs of the generic distinction and Dinosaurian affinities of the extinct animal.

* 8vo. ed., 1860, p. 258.

† Gr. *σκελῖς*, *limb*, *σαυρος*, *lizard*; from the indications of greater power in the hind legs than in most Saurians.

Femur. Tab. I.

I may premise that the femur of the *Iguanodon* is characterised by the deep and narrow fissure dividing a compressed external trochanter from the head of the bone, and by a process from the middle of the shaft, on the inner side, opposite to the part where the "third trochanter" projects in some of the large herbivorous mammals (*Perissodactyla*). Both these characters are repeated in the specimen of the uncompressed shaft of the femur represented in Tab. I; but the shaft, viewed sideways, as in fig. 3, shows a more decided sigmoid flexure than in the *Iguanodon*, and the fissure between the great trochanter (*e*) and the proximal end of the bone (*c*) is relatively deeper. The exterior surface of the shaft is smooth, and in the present fossil glistens, and is, as it were, bronzed by a thin coating of pyritic salt. The proximal end of the bone (*c*) divided by the cleft from the great trochanter (*e*) is subcompressed from side to side below the swelling out of the head, and is extended from before backwards; the head itself, or articular end of the bone, has been broken or abraded away, showing a fine cancellous structure at that part (fig. 3, *c*). The antero-posterior diameter of this part is 6 inches; the transverse diameter, opposite the base of the outer trochanter, is 3 inches 8 lines.

The fore part of the shaft (fig. 2) shows at its upper half a flattened, oblong, rather rough surface (*f*) for muscular implantation. Below, and on the outer side of this surface, is a rough, roundish, slightly prominent tuberosity (*s*), continued at its inner side into a ridge, which descends with a slight curve outwards on the fore part of the middle of the shaft of the femur, where it terminates in a point at *v*. These risings indicate the force of the large muscles acting upon the limb, and by their insertions raising and drawing forward the femur. The elongated base of the inner process (fig. 3, *t*) becomes slightly narrower as it descends; its full extent is not recognisable, by reason of the wall of the shaft being there broken away, exposing the medullary cavity (*m*). Behind the base of the process is a large, oblong, rough ridge, indicating the extension of the surface of attachment, behind and beyond the process itself, for a powerful muscle depressing and drawing back the femur. I do not find this character so well marked in the femur of the *Iguanodon*. The homologous roughness is present, without the process, in the femur of the *Megalosaur*. From the great trochanter (*e*) a narrow, rough surface, not projecting as a ridge, extends nearly straight down the outer and back part of the shaft (fig. 1 *o*). Exterior to this surface is an oval foramen (*a*), most probably for the passage of the blood-vessels and nerve to the medullary cavity.

The transverse section of the middle of the shaft is nearly circular; the thickness of the compact wall of the medullary cavity is here about one sixth of the transverse diameter of the bone. I have not seen a bone of any other Dinosaur indicative of more vigorous action of the hind limbs than the present femoral shaft.

The foregoing interesting and instructive fossil was accompanied by the shaft of a tibia of corresponding size, crushed and broken at both ends; it measured 18 inches in length and 2 inches 8 lines in diameter at its middle, the circumference of the shaft there being 10 inches.

These proportions indicate a hind leg, longer and more slender, relatively to the trunk, than in the *Megalosaur*, *Iguanodon*, or other Dinosaur with which such comparison may be made. The bone being fractured across the middle of the shaft, shows a large medullary cavity; the compact, bony wall does not exceed 3 lines in thickness, the cavity itself being 1 inch 3 lines in diameter.

At the proximal end the antero-posterior expansion and its ridges have been broken away. The bone gradually contracts, as it descends, to a subtriangular shaft, with a triangular transverse section, two of the angles being rounded off, and the third remaining, which was opposite the fibula. The distal expansion has been, in like manner, broken away; but its commencement shows the rise of an anterior ridge in addition to the fibular one. I did not think it necessary to figure this fossil, as I shortly after received from Mr. Harrison and Mr. Henry Morris, F.R.C.S., of Charmouth, the subjects of the two following plates.

Parts of the Femur, Tibia, and Fibula forming the Knee-joint. Tab. II.

In the specimen figured from three views (figs. 1, 2 and 3) in this plate, the lower half of the right femur and the upper half of the right tibia and fibula are cemented by the matrix in the natural relative position in which they enter into the formation of the knee-joint, when bent. This remarkable specimen indicates the tranquil state of the sea-bed or bottom after it had received the dead carcass of the Dinosaur. No agitation or other external violence has displaced the bones of the leg after the solution of the ligaments which tied them together in the living animal; when the depth to which they had sunk, and the consistency of the mud or clay bed, tended to retain them in their natural position. The portion of femur preserved indicates a slight backward bend of the shaft, which at the fractured part—probably a little below the middle of the bone—presents an almost circular transverse section. The circumference here is 10 inches; the compact wall of the bone is 6 lines thick; the medullary cavity 2 inches in diameter. A little below the fractured end, and 8 inches above

the lower end, the shaft shows the termination of the inner process. From this point the femur expands gradually, and chiefly in the transverse direction. Posteriorly it becomes impressed by the popliteal cavity, which deepens and widens to the upper and back part of the inner condyle; which, by its production towards the outer condyle, contracts the lower end of the popliteal cavity transversely. On the outer side of the distal expansion of the femur, the external wall is in part broken away; but a shallow and narrow longitudinal impression is indicated, terminating below in a rather shallow notch, which marks out the inner and hinder part of the outer condyle from the outer part of the same condyle. This notch corresponds with that between the tibia and fibula, and defines the portions of the outer condyle assigned to those bones respectively. The inner condyle is rather flattened on the inner side (*a*). The tibia is much expanded at the proximal end, chiefly by an extension of the bone forward (fig. 1); it is slightly convex on the inner or tibial side (*e*); a longitudinal prominence extends from the fibular side of the expansion, near the fore part, answering to the ectocnemial process in the bird's tibia; the main expansion forms the procnemial process (figs. 1 and 2, *p*) which has subsided to the ordinary level of the shaft about six inches down the bone. The back part of the proximal end of the tibia (fig. 3) presents two almost hemispheric protuberances (fig. 3, *c, d*), side by side; they might be mistaken in a detached bone for the backwardly projecting condyles of a femur, but are less deeply severed. The outer tuberosity (*d*) articulates with a slight depression in the contiguous part of the fibula (*f*). The fore part of the proximal portion of the tibia is, transversely, concave, exterior to the pro- and ecto-cnemial processes. The fractured part of the shaft, eleven inches below the knee-joint, presents a full, oval section, with the same proportion of compact bony wall to medullary cavity as in the femur; the white spar filling the cavity (*m*) contrasts strongly with the jet-black colour of the petrified bone (*t'*). The transverse diameter of this part of the shaft is 2 inches 3 lines; the fore and aft diameter is 2 inches 6 lines.

The fibula expands chiefly in the fore and aft direction at its upper end (fig. 2, *f*), where it measures 5 inches across. Six inches lower down this diameter has contracted to one of 1 inch 8 lines; eleven inches lower it measures 1 inch 3 lines, the transverse diameter being 9 lines. Seven inches from the proximal end the fibula presents at its outer and back part a thick, longitudinal, rough ridge, for the attachment of a muscle. It continues in contact with, and gets rather behind, the tibia as it descends.

Ungual Phalanx. Tab. II, figs. 4, 5, 6.

The ungual phalanx transmitted with the foregoing leg-bones, from the collection of Henry Norris, Esq., F.R.C.S., is somewhat intermediate in its proportions between that of the hind foot of the *Megalosaurus* and that of the hind foot of the *Iguanodon*; it is less compressed than the former, less depressed and flattened than in the latter. On one side of the base, near the articular surface, it is impressed by a shallow, vertical canal (fig. 6, *g*), extending from the upper to the lower part of the bone. A median, low and broad, vertical prominence extends from the upper half of the articular facet (fig. 5, *b*), giving a sub-crescentic figure to the cavity of the joint; the lower border is straight to near the apex, which is slightly bent down (fig. 4). There are no indications of lateral grooves and foramina for blood-vessels.

Bones of a young Scelidosaur. Tab. III.

Subsequently to the exposure and acquisition of the foregoing fossils an intelligent quarry-man discovered, in the same member of the lower Lias, a collection of small bones, of a delicate, friable texture, of which those comprised in Tab. III were brought to Mr. Harrison, by whom they were kindly transmitted to me for description. The collection included the centrum or body of a vertebra (figs. 1—4), a left femur (figs. 5, 6), a considerable portion of a tibia (fig. 7), and fibula (figs. 8 and 9), a tarsal bone (fig. 15), a metatarsal (figs. 10 and 11), and a proximal phalanx (figs. 12—14). The long bones were much crushed, especially the femur. This bone, therefore, appears to be thicker than it really was, being almost flattened. The articular ends have been in a fibrous, unossified state, so that they appear flatter or less prominent than they were in the recent bone. The external trochanter (*e*) seems entire, and has not risen higher in relation to the head of the bone than is shown in fig. 5. The internal process (*t*) is similarly well preserved, repeating the character of the herbivorous Dinosauria which is exemplified in the *Iguanodon*. The outer condyle of the femur is longitudinally grooved for the fibula. The medullary or unossified cavity of the shaft of the bone has been more considerable, in relation to the compact shaft, than in the large femora previously described.

From the foregoing characters it may be concluded that the present femur has belonged to a Dinosaur, allied to the *Iguanodon*, and to a very young individual, and it most probably formed part of a very young or fœtal *Scelidosaur*.

Fig. 7, Tab. III, is a crushed tibia, with the upper end much produced forward and bilobed behind, as in that of the *Scelidosaur*, the lower end is wanting.

It bears the same proportion to the femur as does the tibia in the specimen figured in Tab. II.

The bone, with the shaft crushed flat, and with a sub-bilobed end (figs. 8 and 9), having the opposite extremity broken away, more resembles a fibula than it does a metatarsal bone.

The bone (figs. 10 and 11) presents the characters of a metatarsal at both its articular extremities, and might well belong, by its general proportions, to the same limb with the femur (fig. 5) and tibia (fig. 7) of Tab. III. Fig. 12 gives a side view, fig. 13 a back view, and fig. 14 a front view, of a proximal phalanx of one of the toes of a foot of corresponding dimensions.

A tarsal bone (Tab. III, fig. 15) presents a peculiar form; one of the larger surfaces (*a*) is impressed with a shallow cavity; it is separated from the opposite surface, for two thirds of its extent, by a smooth, convex, apparently articular, surface, broader at one end of the bone than at the other. The other third of the marginal surface (*b*) presents a triangular, rather flattened, facet. The opposite surface to *a* is also impressed by a cavity, bounded by a sharper margin, which at one end is notched, so that two slight angular projections here appear, as at *b*, fig. 15.

The vertebral centrum presents one terminal surface flat, the other slightly convex; it belongs to the dorsal or lumbar series, all the processes having been developed from the neural arch, which has separated from the sutural surfaces shown in fig. 2. The sides of the centrum (fig. 1) are smooth, concave lengthwise, convex vertically, converging towards the lower border, but in a less degree than in *Iguanodon*; that border is consequently less narrow. The neural canal sinks at the middle into the substance of the centrum (fig. 2). All the characters of this part agree with the Dinosaurian nature of the young reptile which is demonstrated by the femur (figs. 5 and 6).

From the texture, fragility, and evidences of incomplete ossification of the bones represented in Tab. III, I infer them to have belonged to a very young individual, and their occurrence in a marine deposit suggests many reflections.

To whatever extent the Saurian organization has been modified for terrestrial life, that has been, in no instance, such as to suggest an inability to swim. On the contrary, the disproportionate shortness of the fore limbs, even in the *Iguanodon*, leads to the suspicion that they might be short in reference to diminishing the obstacles to propelling the body through water by actions of the strong and vertically extended tail; and that, as in the living land lizard of the Galapagos Islands, called *Amblyrhynchus*, the fore limbs might be applied close to the trunk in the *Iguanodon*, when it occasionally sought the water of the neighbouring estuary or sea. One would suppose that the newly born or newly hatched young of a Dinosaur might be safer on shore than at sea, or at least in waters which, like

those of the Liassic ocean, seem to have swarmed with carnivorous Enaliosaurs. If the Dinosauria were ovo-viviparous, and produced but few young at a birth, the remains from the lower Lias figured in Tab. III might be those of a foetus borne by a gravid Scelidosaur to sea during an occasional excursion, and which by some casualty had there perished, and become imbedded, with her progeny, in the muddy bottom of the old Liassic ocean. I have not, however, been able to obtain precise evidence of the proximity of the small bones above described with any of the larger ones attributed to the *Scelidosaurus*, and bones of more than one small individual might have been expected to occur in juxtaposition if they had perished before birth. The analogy of the crocodile, moreover, would lead us to expect that the newly excluded or newly born Scelidosaur would be of smaller size than the individual indicated by the bones in Tab. III.

The Skull. Tabs. IV, V, VI.

The foregoing indications of a Dinosaur in the lower Lias excited speculation as to whether it had been herbivorous, like the Iguanodon of the newer Mesozoic beds, or carnivorous, like the Megalosaur, which has been traced from Wealden down to the "great Oolite." The structure of the femur pointed the former way, but the proof which the dentition only could give was wanting.

The persevering encouragement afforded by Mr. Harrison to the workmen in the Lias quarries has, however, been rewarded by the acquisition of the fine specimen of a skull which forms the subject of Tabs. IV, V, and VI.

The teeth, in their close-set, thecodont implantation, relative size to the jaw, degree of expansion, and general shape of the crown, resemble those ascribed to the *Hylæosaurus* (p. 21, tab. viii, figs. 1—3, 'Monograph on Wealden Reptilia,' 1857); but the crown presents the median longitudinal prominence and marginal serrations which bring it closer to the Iguanodont pattern; and, in the degree in which they depart therefrom, they still more closely resemble the teeth of the *Echinodon* from the Purbeck,* which may prove to be a small kind, or young, of a Dinosaur. They, however, present different proportions.

Referring, therefore, the skull in question to the Dinosaurian order, it supplies most acceptable information as to the cranial structure of that group, which no previous example from Oolitic and Wealden beds has been sufficiently perfect to impart.

Of *Iguanodon*, *Megalosaurus*, and *Hylæosaurus*, portions of lower jaw, and mere fragmentary bits of the upper jaw, palate, and basis cranii, are all that have hitherto come to light. But the present specimen is the entire skull, wanting only the fore end of the upper and lower jaws.

* 'Monograph on the Fossil Lacertian Reptiles of the Purbeck Limestones,' p. 35, 1858.

The cranium has been slightly crushed and distorted by oblique pressure, due to movements of the matrix after imbedding and petrification. The right halves of the mid-frontal and nasal are depressed a little below the level of the left halves of the same bones, and the right diverging branch of the parietal has been broken from the rest of the bone, near the median line, and dislocated by the same pressure from its union with the mastoid. The right ramus of the mandible, accompanying the movement of that side of the head, has been pushed so far below the left ramus as to have its inner side brought into view in the profile of the skull given in Tab. IV.

The occipital conforms to the Lacertian type in the proportions and direction of the par-occipital; this process is long, narrow, straight, directed outwards, compressed from before backward, and slightly expanded at the extremity, which is applied to the back part of the mastoid and tympanic at the junction of those bones. It has been slightly displaced, its end appearing on the left side at 4, Tab. IV, with matrix intervening between it and the tympanic (28). A part of the exoccipital which projects backward to contribute to the formation of the condyle, is exposed near the mass of matrix, including the atlas vertebra and nuchal dermal bones.

The cranial part of the skull, posterior to the orbits, is shorter in proportion than in the lizards, and resembles, in this respect, that of the crocodiles. The parietal is short, and bifurcate behind, as in lizards. The body of the bone, or part between the temporal fossæ, is subcompressed where it forms the smooth, concave, inner sides of those depressions, which do not meet above, but are separated by a narrow, flat tract; this might be converted into a ridge in older individuals. The fore part of the parietal slightly expands where it is overlapped by the frontals. Each hind branch of the parietal extends outward and a little backward; its pointed end is obliquely overlapped anteriorly by the inner branch of the mastoid, completing therewith the hind boundary of the temporal fossa. The crushed and dislocated state of the calvarium along its middle line does not permit the usual evidence of a foramen parietale to be detected, but the appearances are against such perforation being present. This foramen is not constant in modern lizards; the *Scelidosaurus* may agree with *Cyclodus* and *Tejus* in this respect. The parietal bone, as a whole, plainly accords with the lacertian, not with the crocodilian, type of that bone.

The mastoid (8) is a triradiate bone, forming the upper and hinder angle of the cranium, from which one ray passes inward to join the parietal (7), a second ray forward to join the post-frontal (Tab. V, 12), and a third ray downward to join the tympanic (28). A fracture of the body of the mastoid, by which the anterior branch is broken away on the left side (Tab. IV, 8), exposes a cancellous cavity, probably forming part of the organ of hearing.

The two halves of the mid-frontal have been separated along the medial line, and the right half depressed. The separation appears to have been at a suture, as is certainly the case with the nasal bones; the medial margin of three fourths of the left frontal show the jagged, sutural character. I conclude, therefore, that the mid-frontal was divided, as in the *Ichthyosaurus*, and as in *Varanus* and *Lacerta* proper; and that it was not a single bone, as in the *Iguana* and most *Lacertilia*, and as it is in the *Crocodylia*. Each half of the frontal in *Scelidosaurus* is a long, inequilateral triangle, the medial being the longest side, the posterior, which joins the parietal, the shortest; the antero-external border is irregularly and deeply notched, uniting with the post-frontal, super-orbital, pre-frontal, and nasal bones; it is excluded, as in *Lacerta* proper, by the large super-orbital bone (71) from the orbit. The outer surface of the frontal is sculptured by irregular lines and grooves, but less deeply than in *Crocodylus*.

The post-frontal (12) forms the back and part of the upper border of the orbit, uniting with the super-orbital, the frontal, and malar, and sending backward an angular process to join the mastoid, completing the upper bar or zygomatic arch of the temporal fossa. This arch had been broken away on the left side (Tab. IV), but is preserved on the right side (Tab. V, 8, 12).

The pre-frontal presents a horizontal and a vertical portion; the former and larger part is wedged between the frontal, superorbital, and nasal bones, the descending plate joins the lacrymal (73), and touches the upper angle of the maxillary (21). In the *Crocodylus* the aspect of the whole outer plate of the pre-frontal is upward; in some *Lacertians* the major part looks outward.

The nasal bones (15, Tabs. V and VI) unite above and behind with the frontal (11) by a short border, obliquely and irregularly cut, to include the pointed anterior ends of the lateral halves of the frontal; the nasals expand as they advance, in union, first, with the pre-frontals, then with the maxillaries, where they slightly decrease in breadth. The mutilated fore part of the skull precludes the determination of the relations of the nasals with the pre-maxillary, and of the character of that bone. That of the outer plate of the nasals looks upward; the maxillary border is slightly bent down (15, fig. 2, Tab. V), and is overlapped by the maxillary (21, ib.)

The fractured fore part of the skull in the above-cited figure shows the superior thickness of the median and lateral borders of the nasals, the intervening part being, as it were, channeled below for the air-passage; this has not here been divided by any ossified vertical septum; the thickened palatal and alveolar parts of the maxillary, as they bend toward each other, present a convexity transversely to the nasal passage. This is closed below, as it seems, by the vomer (13).

Of the hind part of the bony palate the pterygoid was brought into view by removing the matrix between the diverging rami of the mandible. The body of

the bone is in the form of a subtriangular plate, of 1 inch 7 lines extent along its mesial border, which is slightly concave, receding from its fellow at the medial line, or base, as in the Iguana; the apex extends outward, and a little downward to abut against the fore and inner part of the ectopterygoid. From the hind border near the base a long and narrow process is sent off to abut against the tympanic. There is no trace of teeth on the pterygoid, as in the recent Iguanas; the higher type of Saurian dentition is retained in *Scelidosaurus*.

The hind and probably main part of the maxillary, here preserved, is chiefly remarkable for the horizontal ridge which nearly equally divides the outer or facial plate of the bone into an upper and lower facet; and this ridge is continued a little way below the orbit upon the malar bone. It corresponds with the more strongly marked ridge in *Ptychognathus* and *Oudenodon*. There is a lower and slighter longitudinal prominence of the maxillary along the outer alveolar plate. The maxillary reaches back beyond the middle of the orbit, from which it is separated, as in other Saurians, by the malar and lacrymal bones.

On both sides there is a small, unossified space between the maxillary and lacrymal; this corresponds with the larger vacuity in that part of the bones of the face in the Pterodactyle, which is reduced to the present proportions in some Teleosaurs, and becomes the functional nostril in the Ichthyosaur; but I believe that the true external nostrils of *Scelidosaurus* were included in the fore part of the skull which has been broken away, and were, as in the Teleosaur, distinct from the maxillo-lacrymal vacuities.

The orbits of *Scelidosaurus* are subcircular, almost vertical, looking outward. Were the super-orbital ossicle in *Crocodylia* enlarged and fixed by suture in the upper scoop of the orbit, it would give a less vertical outlook to the eye than it usually presents, especially in the skull of a crocodile from which that ossicle has been removed. But the composition of the rim of the orbit in *Scelidosaurus* is open to other homologies. The bone (71) may be compared with that wedged into the upper and back part of the orbit in some lizards, between the frontal and post-frontal, and by Cuvier regarded as a dismemberment of the latter element; only in *Scelidosaurus* it is extended forward to the pre-frontal, excluding the frontal from the orbit. In *Ichthyosaurus* the post-frontal has a like forward extension and junction with the pre-frontal, but it also passes backward to join the mastoid, leaving to the bone at the back of the orbit a simple post-orbital function. In *Scelidosaurus* the bone which joins the mastoid also sends down the post-orbital bar to join the malar; so that I find no nearer approach to the peculiar structure of the upper part of the orbit in *Scelidosaurus* than the Crocodile would give with a somewhat more fixed and developed superorbital bone.

The delicate lacrymal bone (73) appears to have been fractured on the left side

(Tab. IV); on the right side (Tab. V) it seems to be entire. The malar bone (26) begins anteriorly, in a pointed form, between the lacrymal and maxillary, increases in depth as it extends beneath the orbit, sends up a process which bifurcates to receive the point of the post-frontal in the cleft (Tab. V, 27), and extends backward and downward as a slightly convex and somewhat roughened plate, which articulates by its lower convex, but somewhat irregular, border with the squamosal (27). The posterior border of the malar presents a regular and well-defined, concave curve. The chief peculiarity of the bone is its unusual vertical extent posteriorly. This extent seems to be increased by the squamosal (Tabs. IV and V, 27), which articulates with the lower border of the produced part of the malar, and expands to be articulated with the outer part of the lower half of the tympanic (28), the upper angle rising above the terminal articular part of the malar. This deep and powerful arch of bone, answering to the zygoma in mammals, may have afforded attachment to large, masseteric muscles operating upon the lower jaw. Similar muscles may have been extended between the ridges of the upper and lower jaws. The tympanic is a long bone, compressed from before backward, almost vertical in position, with a slight forward bend, but firmly wedged between the mastoid and par-occipital above and between the squamosal and pterygoid below.

The back part of the tympanic is convex transversely at its inner half, concave at its outer half, where the margin is slightly produced to join the upper part of the squamosal; the inner part of the tympanic is more extended where it is overlapped or abutted on by the pterygoid (Tab. VI, fig. 2, 24). Below this expansion the tympanic becomes contracted and thickened, forming a kind of neck to the terminal condyle.

In the vertical position and length of the tympanic, *Scelidosaurus* resembles the *Lacertia*; in its fixity and extent of its connexions, it resembles the *Crocodylia*.

The lower jaw includes in each ramus an articular (29), a surangular (30), a coronoid (30'), an angular (31), a splenial (32) and a dentary (33) piece.

The articular (Tab. VI, fig. 2, 29) is situated in the inner side of the surangular, and is thickened and projects inward to form the cavity for the major part of the tympanic condyle, the outer border of which rests on the surangular. This element (30) convex externally, presents a longitudinal ridge near its upper part, which rises to join the posterior angle of the dentary element in forming a low coronoid process. The angular (31) does not extend beyond the surangular, but makes with it the angle of the lower jaw; it grows in vertical extent as it advances, is convex externally, unites with the dentary, and sends forward from its lower part a pointed process between the dentary and splenial elements. The splenial (32) makes a small appearance on the outer side of the ramus, between the angular and dentary, but is chiefly visible as a broad, smooth

plate (Tab. VI, fig. 2, 32), applied to the inner side of the dentary. The dentary (33) is a very powerful bone, with the outer surface divided into an upper and lower facet by a longitudinal ridge paralleling that of the upper jaw. The ridge (Tabs. IV and V, 33), commencing near the base of the coronoid process, descends, describing a slight curve to the middle of the outer surface of the dentary. Below the ridge the bone is convex, above it is concave; the lower facet has the kind and degree of roughness observable on the exposed surface of most of the cranial bones; the upper facet has a smoother surface, corresponding in that respect with the surface below the ridge of the maxillary.

The foregoing character of the lower jaw has, hitherto, been observed only in a fossil one, which has been referred to the Dinosaurian order; by Mantell,* originally to *Iguanodon*, and afterwards, when it had been shown to be more probably part of the *Hylæosaurus*,† to a genus which he called *Regnosaurus*.‡ In this portion of the ramus of the mandible (No. 422, Reptilian Fossils, British Museum), the outer surface of the dentary is divided into an upper and lower facet by a longitudinal ridge, which, commencing near the upper margin, probably at the base of a coronoid rising, descends as it advances to midway between the upper and lower border. It is, however, more obtuse than in *Scelidosaurus*, but the upper facet presents a like smoothness and vertical concavity.§ In size the specimens closely correspond, and also in the close arrangement of the series of teeth. But these were relatively smaller and more numerous in the Wealden fossil; for whereas in *Hylæosaurus* ten teeth, or their sockets, occupy an extent of 1 inch 8 lines of the alveolar border, the same extent includes only seven and a half teeth or sockets in *Scelidosaurus*. In this genus, moreover, the ramus of the mandible presents a curve convex downwards, to about the same degree as the opposite curve is presented by the corresponding part of the jaw of *Hylæosaurus*, in which this peculiar bend is noticed by me in a former monograph.|| In the mandible of *Scelidosaurus* a ridge, corresponding, perhaps, to the lower ridge in *Hylæosaurus* is situated further back and higher up upon the surangular; and the facet, concave vertically between the lower ridge and the beginning of the upper ridge,¶ is peculiar to the mandibular fragment referred to the *Hylæosaurus*. Thus, with corresponding Dinosaurian character, imparting robust strength to the mandible, there are well-marked generic distinctions in the specimens here compared, both in the conformation of the jaws and teeth.**

The mandibular rami of *Scelidosaurus* describe a slight, but graceful, sigmoid

* 'Wonders of Geology,' 1838, vol. i, p. 393.

† "Report on British Fossil Reptiles," 'Trans. of Brit. Association,' 1841, p. 120.

‡ 'Philos. Trans.,' 1848.

§ See tab. viii, fig. 5, 'Monograph on Wealden Reptilia' (1856).

|| Ib., p. 19. ¶ Ib., tab. viii, figs. 1 and 4. ** Ib., tab. viii, figs. 6—9.

curve from the angle forward, horizontally, at first concave, then convex, towards the median line, where they meet without blending at the part fractured. It is not probable that the symphysis would be much prolonged beyond this point. The degree of convergence of the contour lines of the whole skull, both median and lateral, with the decreasing size of the anterior teeth, makes it more probable that but a small proportion of the muzzle is wanting in the present specimen (Tabs. IV and V). The analogy of the *Iguanodon* might be unsafe ground for inferring as short a symphysis mandibulæ in *Scelidosaurus*, but it would accord with the other indications of such a proportion of the conjoined ends of the rami.

Dentition. Tabs. IV and V.

The specimen of *Scelidosaurus* here described has been buried and petrified with the mouth shut; there has been no dislocation of the under jaw, and the skull shows that the teeth of the upper jaw overlapped and concealed those of the lower. The crowns of both series were a little inclined inward, as shown at the fractured fore part (Tab. V, fig. 2, *a, b*); this, with the similar inclination of the alveolar plates, produces a feature which reminds one of that of toothless anility, or of the effect of sucking in the cheeks, in man.

The teeth are small, or of Lacertian proportions to the jaws; they are numerous and close-set, implanted in sockets forming an uninterrupted series along the alveolar border. The fang is simple, and longer than the crown, presenting a full ellipse in transverse section, and projecting a little beyond the socket. In the upper jaw the crown (Tab. V, fig. 3) begins by bulging outward, with a smooth convexity, subsiding as it gradually expands, and dividing to be continued along the middle and the margins, with intervening concavities, producing an undulated surface across the broadest part of the crown. The marginal convexities or ridges terminate each in a point at the broadest part of the crown; whence, the plate-shaped tooth having thinned off to an edge, this is divided on each side into five or six smaller points: these denticulate margins converge straight, at an angle rather less than a right one, to the apex of the tooth, which is formed by the pointed termination of the median convexity. The crown is coated by a polished enamel, of jet blackness in the fossil, smooth under the lens upon the convexities, finely punctate in the hollows of the expanded part of the crown. The whole tooth in the upper jaw is very slightly bent backward, with as slight an oblique twist, making the hinder angle overlap the front angle of the crown of the tooth behind.

The inner surface of four of the hind teeth of the right ramus of the jaw shows a crown with a larger proportion of the serrated part, and with the borders less equal, the anterior one showing as many as nine points, and the expanded coronal surface is uniformly and gently convex.

On the left side, in an extent of the alveolar border of the upper jaw measuring 4 inches, there are nineteen sockets, and only one tooth missing. On the right side, in an extent of $3\frac{1}{2}$ inches, there are sixteen sockets, and three teeth missing. The fractured part of the jaw yields evidence of the usual reptilian provision for successional teeth in reserve alveoli, containing tooth-germs, at the inner side of the base of the teeth in place (Tab. V, fig. 2, c). The teeth gradually increase in size from the hindmost to the fifth in advance, continue of about the same size to the tenth, and then gradually decrease in size to fractured fore part of the jaw.

Were the serrated borders of the terminal half of the crown to be worn down, the teeth of *Scelidosaurus* would be like those referred to *Hylæosaurus* in my Monograph of 1856.* There is no evidence, however, that any of them have been so worn down; in this respect they resemble more the teeth of *Echinodon*, the upper teeth in *Scelidosaurus* differing chiefly in the proportions of length to breadth of the crown. Whether the anterior teeth had the simple lanariform character at the fore part of the jaws in *Scelidosaurus*, as in *Echinodon*, remains to be proved. The finely and sharply serrated and pointed teeth of the *Scelidosaurus* glided upon each other, the upper on the outerside of the under, like the blade-shaped crowns of the carnassials of feline mammals; and yet the similarity of the teeth, in their number and uniformly small size, to those of the modern Iguanas suggests that they may have been put to like uses. The compressed, serrate crowns in those herbivorous lizards worked obliquely upon each other, in a similar scissor-blade way. In *Iguanodon* the dentition is obviously modified more decidedly for mastication of vegetable substances. In *Scelidosaurus* it is adapted for division of such substances, but it would be equally effective in piercing and cutting or tearing through animal textures.

If this Dinosaur occasionally went to sea in quest of food, it may be expected to present in the fore part of the jaws, wanting in the present specimen, lanariform teeth, as in *Echinodon*, for the prehension and retention of living prey. Should these prove to be absent, and the dental series to begin as it ends, it will incline the balance of probability to the phytophagous nature of the Liassic *Scelidosaurus*.

* 'Monograph on Wealden Reptilia,' p. 21, tab. viii, figs. 6—9.

MONOGRAPH
ON
THE FOSSIL REPTILIA
OF THE
KIMMERIDGE CLAY.

PLIOSAURIS GRANDIS.

PLESIOSAURUS GRANDIS, *Owen*. 'Report on British Fossil Reptiles,' 8vo. 1839, p. 83.

PLIOSAURUS — *Owen*. *Ibid.*, 1840, p. 54.

Tooth. Tab. VII.

Although abundant evidence of the huge dimensions of the present species of short-necked Sauropterygian has reached me since its first indication from the fragmentary evidence described in my 'Reports' of 1839 and 1840, no specimen has more strongly impressed me with the bulk and power of the old tyrant of the upper Oolitic seas, or, indeed, had exemplified its size on such a scale, as the portion of tooth from Kimmeridge Clay, near Oxford, figured in Tab. VII. This unique specimen forms part of the Palæontological collection of the Hon. Robert Marsham, to whom I am indebted for the present opportunity of describing it.

The circumference of the base of the crown measures 7 inches 6 lines, equalling that of a large-sized tooth of a Cachalot (*Physeter macrocephalus*). Of the enamelled crown 3 inches are preserved, and about as much of the cement-covered base, the largest diameter of which is 2 inches 6 lines; that of the fractured end of the crown is 1 inch 3 lines. The length of the entire tooth may be estimated at between 9 and 10 inches.

The fractured part of the base exposes a pulp-cavity (figs. 3, 5) of about 2 inches in diameter, with a hard dentinal wall of from 4 to 6 lines in thickness; the tooth would seem, therefore, to be one that had been but recently protruded. The fractured part of the crown exposes a solid and compact mass of dentine. The generic characters of the tooth stand boldly out, and the crown is subtrihedral, with the two inner or concave sides continued into each other by an uninterrupted curve, and the angles between these facets and the outer or convex side of the tooth being blunted, or rounded off. The terms concave and convex refer to the longitudinal direction; all the sides are convex transversely, the outer one being the least so. This facet (fig. 1) is further distinguished by the finely wrinkled and unridged surface of the enamel. The wrinkling is produced by short, obtuse, wavy risings, frequently joining, or reticulate, and rather affecting the longitudinal course. The same character is presented by the enamel covering the contiguous parts of the other sides of the tooth, and extends furthest in that represented in

fig. 2, and between the more distant longitudinal ridges on the side represented in fig. 3. There are no longitudinal ridges on the convex side (fig. 1). The enamel here, which is a mere film at the base of the crown, slightly increases in thickness towards the apex; its adhesion to the dentine is promoted by numerous fine, wavy, longitudinal, nearly equidistant, linear risings on the surface of the dentine.

On the side of the tooth fig. 2 the wavy risings of the enamel become larger, more distinct from each other, and more markedly longitudinal, as they recede from the angle dividing it from the convex side. At about an inch distance there is a definite, longitudinal ridge, of an inch in length, followed by other ridges that quickly increase in length as they approach the concave side of the tooth, having pretty regular intervals of about 2 lines. Between these long and well-marked enamel ridges there are other shorter ones proceeding from the base of the enamel, of varying lengths.

On the side of the tooth fig. 3, which transversely is more regularly convex than the side fig. 2, the strong, longitudinal, enamel ridges begin near the angle dividing it from the smoother convex side, at first with interval of about 3 lines, the intervening enamel being wrinkled, then with intervals of 1 or $1\frac{1}{2}$ line, the more numerous longitudinal ridges continuing along the inner or longitudinally concave, but transversely very convex, part of the crown of the tooth. Of these more numerous and closely set ridges, probably the alternate ones only would be extended to near the apex of the tooth, a few of the others being shown to terminate at or near the fracture. The longitudinal ridges are strongly and definitely raised from the general surface of the enamel, and preserve their thickness to near their termination.

The outer longitudinal contour of the tooth (*a*, fig. 2) describes a simple and slight convexity; the inner one is wavy, passing from the slight concavity at the crown (*b*) to a corresponding convexity at the junction of the crown and base, and then again becoming very slightly concave. The transverse diameter of the crown is rather less across the convex side (fig. 1) than in the direction at right angles to this, as from *a* to *b*, fig. 2.

An entire crown of the tooth of a *Pliosaurus*, of the size more commonly met with, is described and figured in my 'Odontography' (p. 282, pl. 68, fig. 5).

In the lower jaw of the *Pliosaurus* from Kimmeridge Clay at Market Raisin, preserved in the Geological Museum at Oxford, there is evidence of thirty-eight teeth in each ramus, which were probably opposed to as many in the upper jaw.

I estimate the lower jaw of the *Pliosaurus*, to which the tooth figured in Tab. VII belonged, at about 8 feet in length.

J. C. Mansel, Esq., of Langthorne, Blandford, Dorsetshire, has favoured me with a photograph of the lower jaw (7 feet in length) of a *Pliosaurus* in his museum. I hope to include a description and figure of that specimen in a future monograph.

TAB. I.

Scelidosaurus Harrisonii.

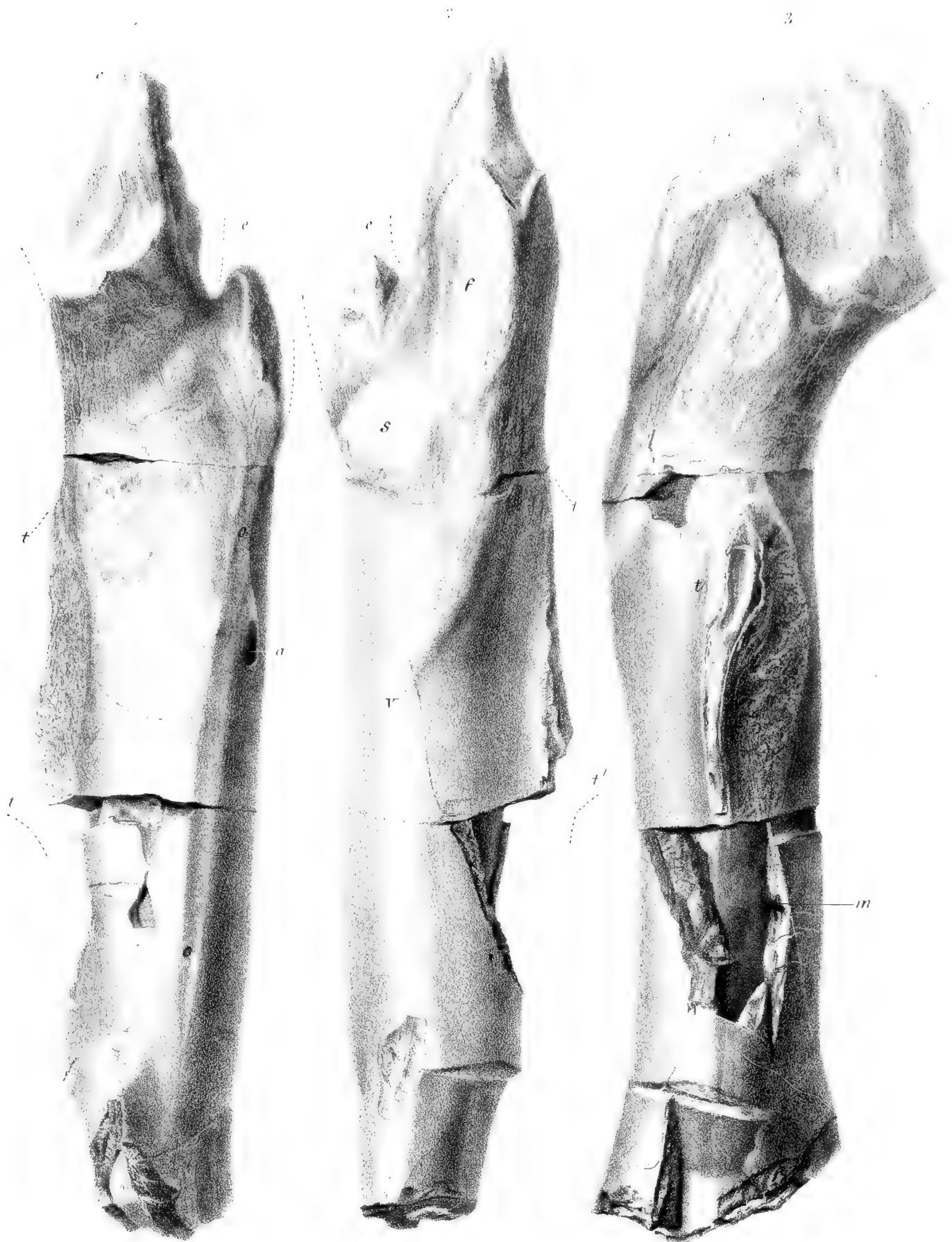
Shaft of femur, half nat. size.

FIG.

1. Front view.
2. Back view.
3. Inner side view.

From the upper part of the Lower Lias, Charmouth, Dorsetshire.

Mus. Norris.



Jos Dinkel del et lith

TAB. II.

Scelidosaurus Harrisonii.

Bones forming the knee-joint, one third nat. size.

FIG.

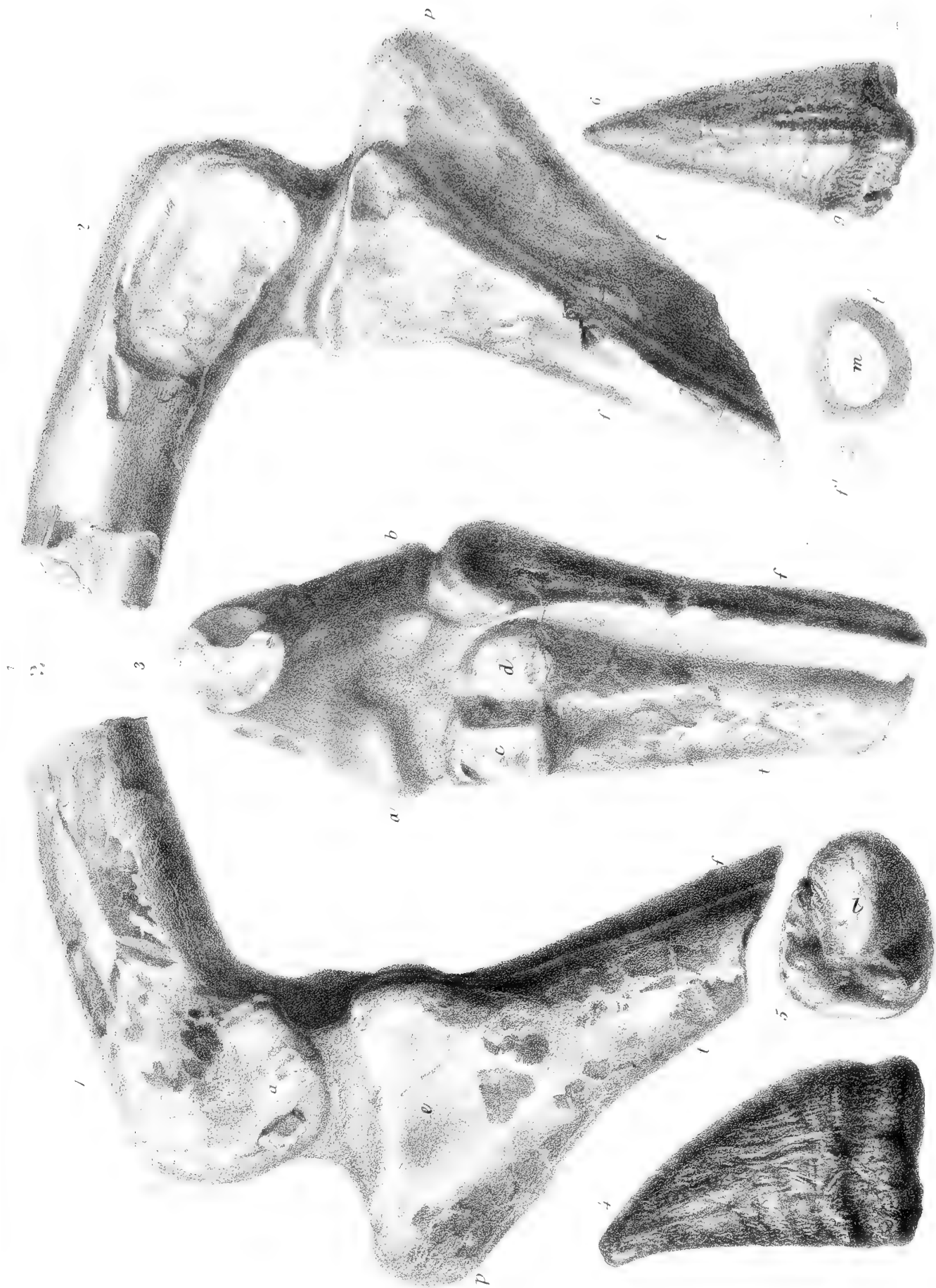
1. Inside view.
2. Outside view.
3. Back view.

From the upper part of the Lower Lias, Charmouth, Dorsetshire.
Mus. Harrison.

Ungual phalanx, or claw-bone, nat. size.

4. Side view.
5. Articular surface.
6. Upper view.

From the same formation and locality. Mus. Norris.



TAB. III.

Scelidosaurus Harrisoni.

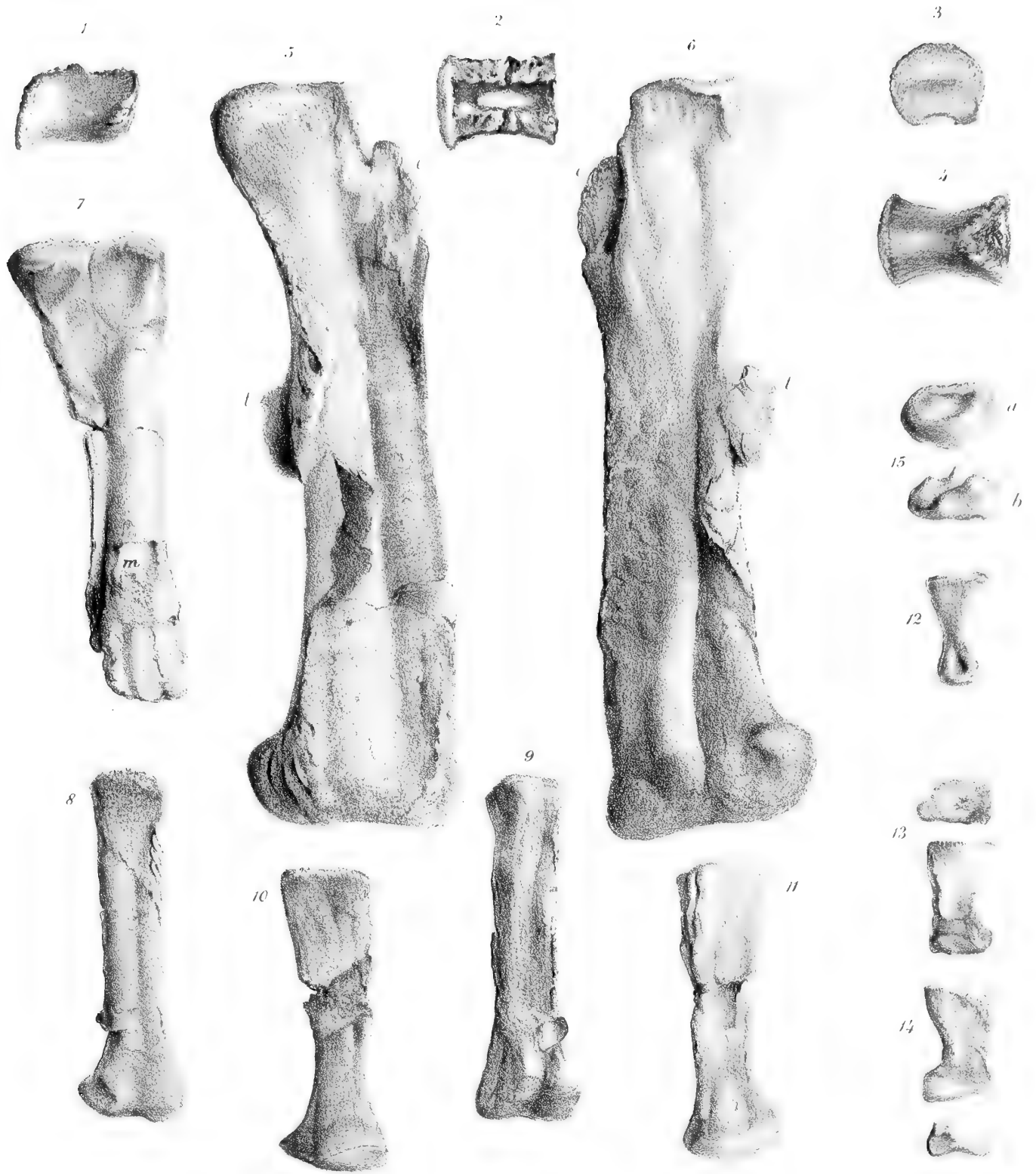
Bones of a very young individual, nat. size.

FIG.

1. Side view of centrum of dorsal vertebra.
2. Upper view of the same
3. End view of the same.
4. Under view of the same.
5. Front view of a crushed femur.
6. Back view of the same.
7. Tibia.
- 8, 9. Portion of fibula.
- 10, 11. Metatarsal bone.
- 12, 13, 14. Proximal phalanx.
15. Tarsal bone.

From the upper part of the Lower Lias, Charmouth, Dorsetshire.

Mus. Harrison.



F Robinson del et lith

W West imp

TAB. IV.

Scelidosaurus Harrisonii.

Side view of the skull, nat. size.

From the upper part of the **Lower Lias**, Charmouth, Dorsetshire.
British Museum.



Jos. Dinkel del. et lith.

W. West, imp.

SCOLIDOSAURUS

TAB. V.

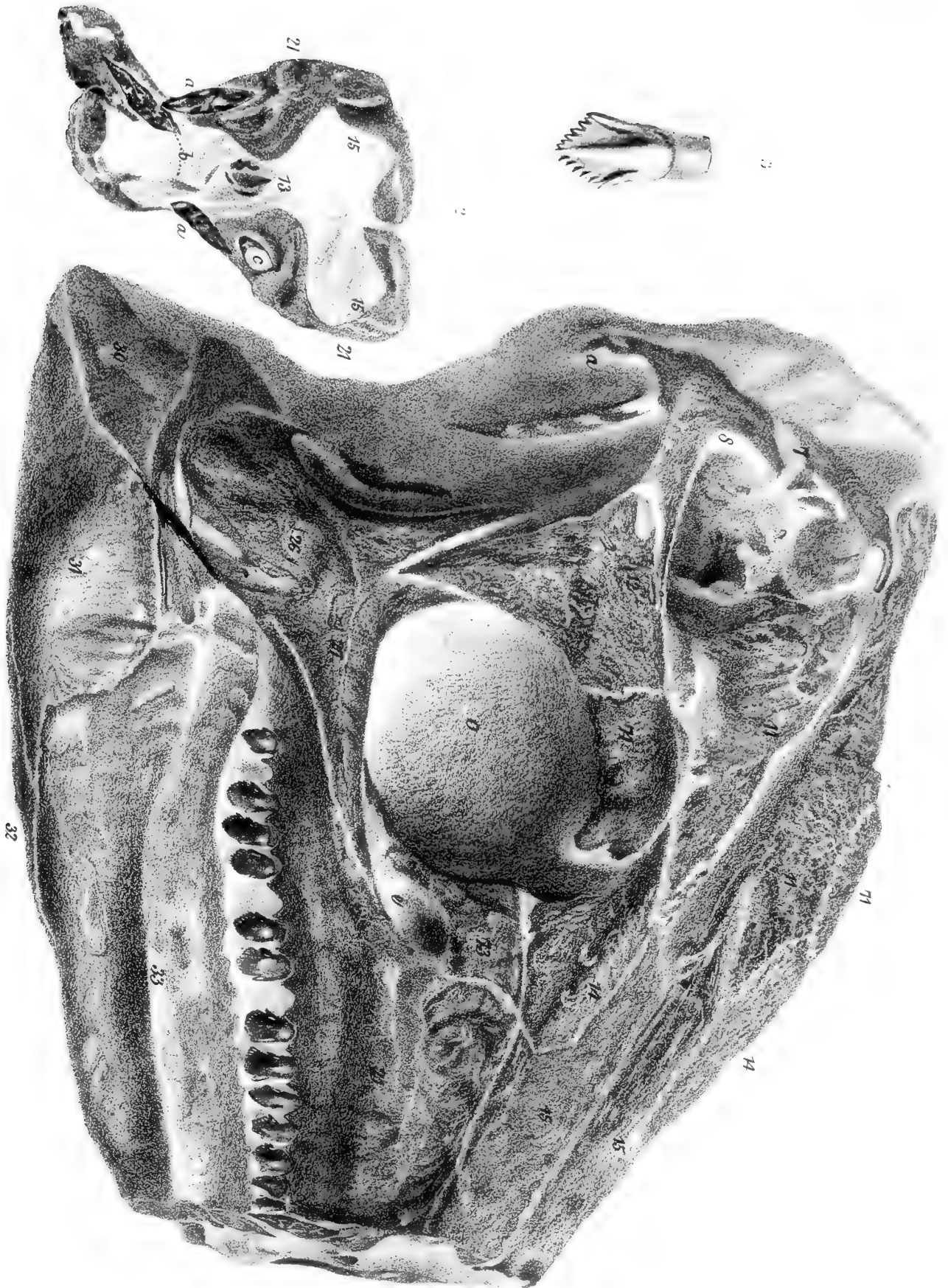
Scelidosaurus Harrisonii.

FIG.

- 1. Side view of the skull, nat. size.**
- 2. Fractured fore end of the same, nat. size.**
- 3. Outer side of an upper tooth, magnified.**

**From the upper part of the Lower Lias, Charmouth, Dorsetshire.
British Museum.**

Fig. 1.



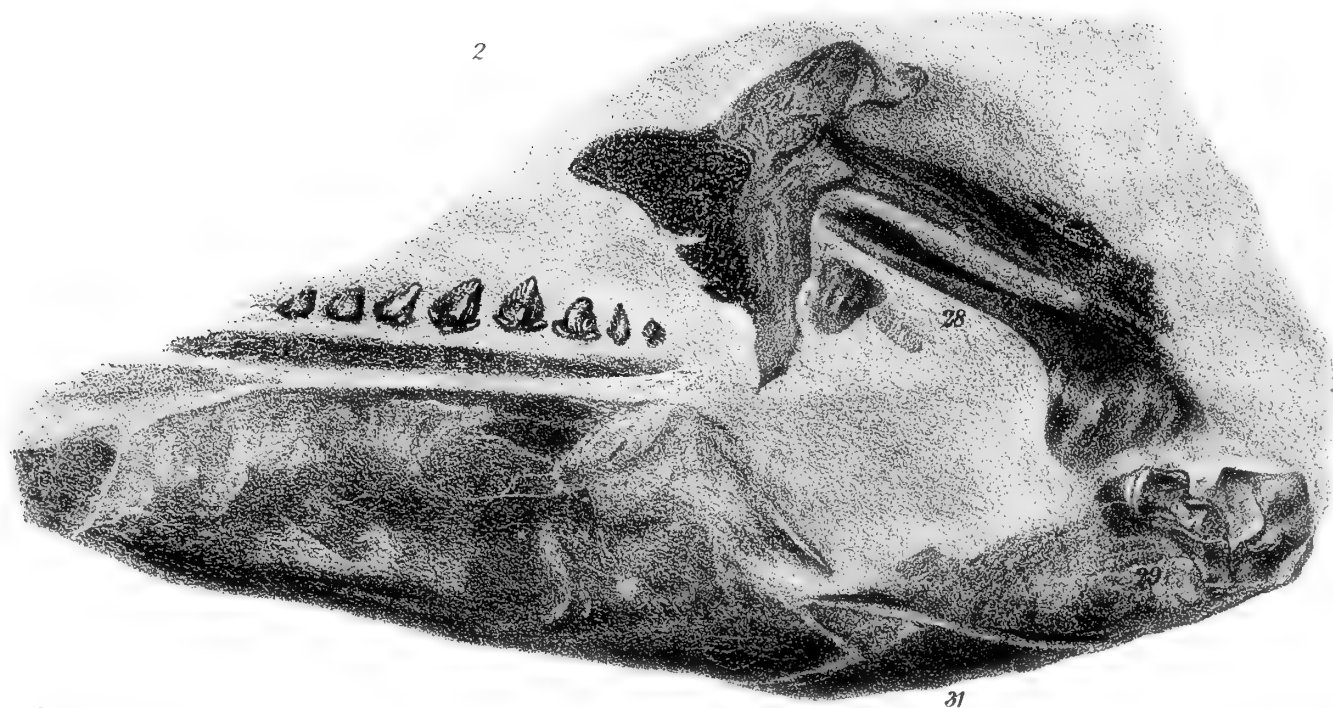
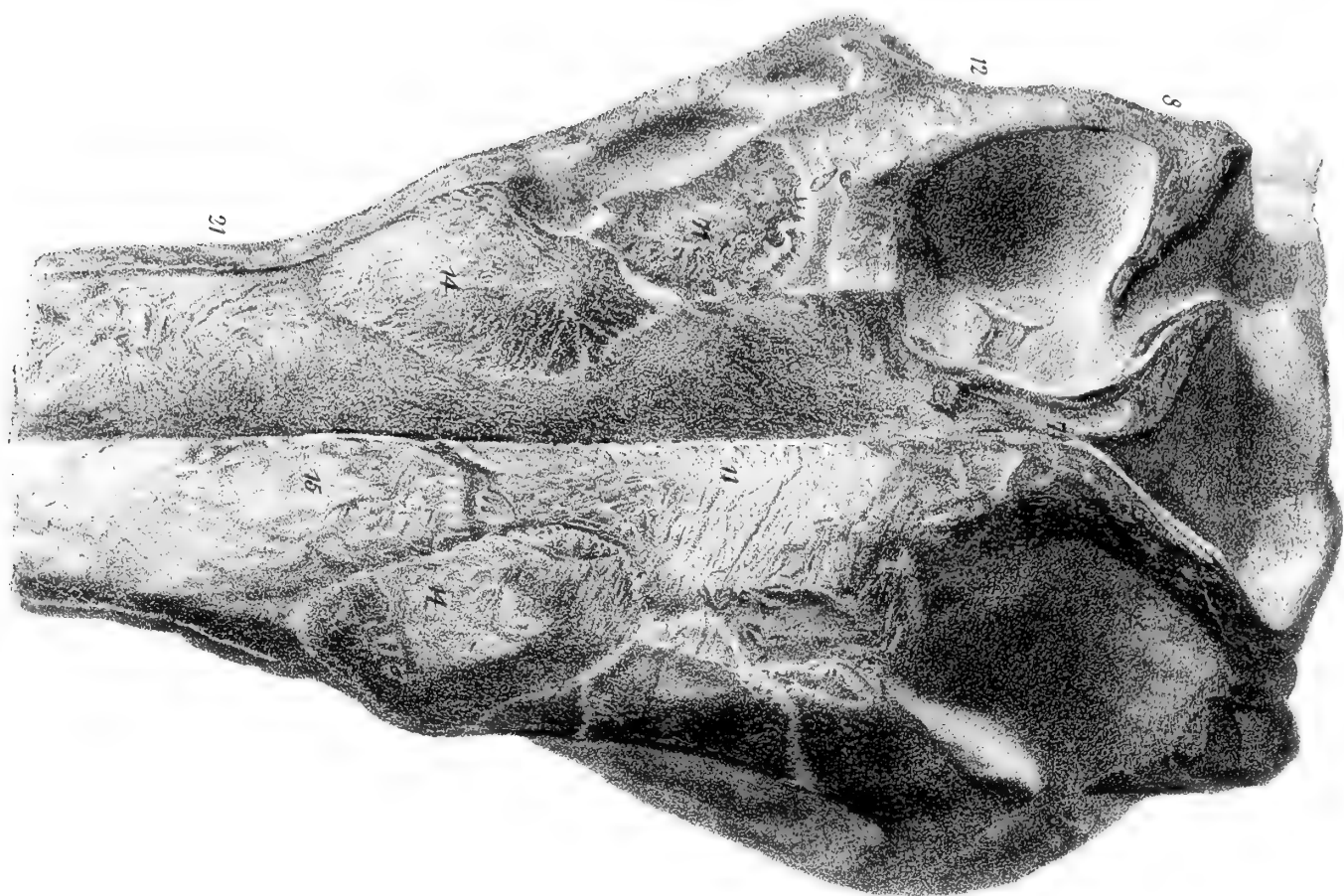
TAB. VI.

Scelidosaurus Harrisonii.

FIG.

1. Upper view of the skull, nat. size.
2. Inner view of right ramus of lower jaw, nat. size.

From the upper part of the Lower Lias, Charmouth, Dorsetshire.
British Museum.



TAB. VII.

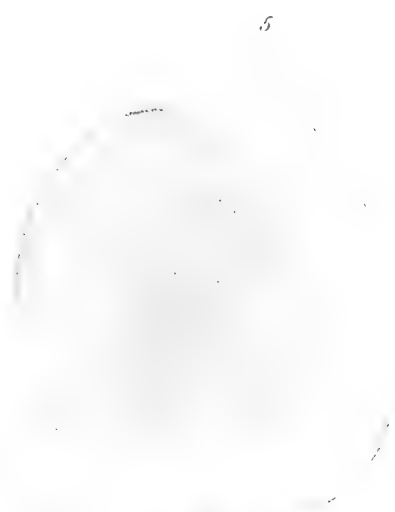
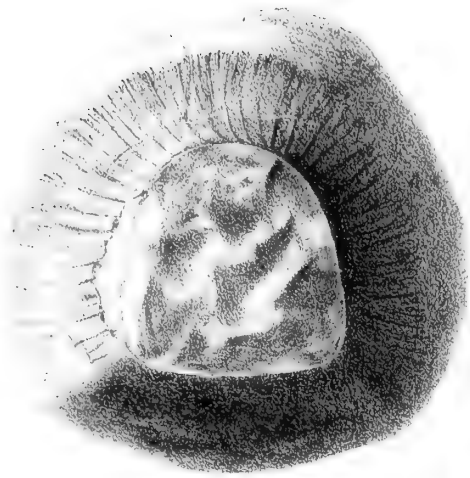
Pliosaurus grandis.

Portion of tooth, nat. size.

FIG.

1. Convex or unridged side.
2. Front ridged side.
3. Back ridged side.

From the Kimmeridge Clay, near Oxford. Mus. Hon. Robert Marsham.



THE

PALÆONTOGRAPHICAL SOCIETY.

INSTITUTED MDCCCXLVII.

LONDON :

MDCCCLXI.

A MONOGRAPH
OF
THE EOCENE MOLLUSCA,

OR,
DESCRIPTIONS OF SHELLS

FROM
THE OLDER TERTIARIES OF ENGLAND.

BY
SEARLES V. WOOD, F.G.S.

PART I.
BIVALVES.

LONDON:
PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.
1861.

P R E F A C E.

IN the year 1846 Mr. G. B. Sowerby proposed to publish at intervals a series of Plates illustrative of the Crag and London Clay Fossils, to which Mr. Edwards and myself had undertaken to supply the descriptions. It was contemplated to issue alternately a number of each formation in furtherance of this object. The first of these serials was to be upon the Crag; and at the meeting of the British Association, held in September, 1846, at Southampton, a specimen plate of the Crag Fossils was exhibited. In January, 1847, Dr. Bowerbank conceived the idea of establishing a society for the purpose of figuring and describing the fossils of Great Britain, in which he was supported by Dr. Fitton, the late Dr. Buckland, and other influential Geologists. There was then in existence a private association, called the London Clay Club, which was composed of a limited number of Tertiary Geologists, who assembled periodically at each other's houses for the study of Eocene Geology, and this was looked upon by the promoters of the contemplated new society as a good promise of material for its support. The desire of encouraging such an object rapidly extended, and a large number of gentlemen speedily enrolled themselves as members of the new society. The Crag Formation had been well examined by myself, and as it appeared to be one that was best known, seemed to offer to the friends of the undertaking the most fitting opportunity for commencement; and as I was particularly desirous of having the Crag fossils figured and described, I conceived this a more certain mode of extending the knowledge of the contents of that formation than the one I had previously entered into, and made arrangements accordingly with Mr. Sowerby for the alteration, and set to work immediately upon the portion allotted to my labours. My friend, Mr. Edwards, as before stated, intended to publish parts alternately with myself; but the older Tertiary Formations being much richer in species, his portion of the work was not so readily prepared as that of the Crag; moreover, what at that time appeared a feasible mode of proceeding has, by the course of events, become

altered, and the known Eocene Mollusca intended to be comprised in his work have since then been so largely augmented in number, as seriously to impede his progress, and to compel him to change his original intention. The prospect once entertained by Mr. Edwards of completing the whole of the Eocene Mollusca thus became so remote that he proposed to me that, as my monograph on the Crag was finished, I should describe the Bivalves of the older Tertiaries.

From a knowledge of the amount of labour my friend has before him ere he reaches the termination of the Univalves, which must occupy him for many years to come, I was induced to consider whether any assistance that I could render in the illustration of these fossils would not be of service to the science of Geology. I felt at first especially reluctant to interfere in any way with a work that has been so ably conducted, but the great desire expressed by Tertiary Geologists to possess an illustration of the Mollusca of the Eocene period in this country still unfigured and undescribed was an inducement to make all other considerations subordinate to that imperious want, and on that ground alone I have consented to attempt to supply such a desideratum. Mr. Edwards has in the most liberal manner promised to place the whole of his Bivalves in my hands, as they may be wanted for examination. His collection of these fossils is the most perfect I have seen, and as the work was intended to be done by himself, the type specimens have and will be taken from his cabinet, except where otherwise particularly expressed; and the principal localities will be introduced on his authority. Mr. Wetherell, Dr. Bowerbank, Mr. Prestwich, the Rev. Osmond Fisher, and all my geological friends, have most kindly permitted me the use of any specimens in their cabinets, and I have to return them my best thanks for their assistance, without which my work would be very incomplete. Mr. Wetherell's collection is particularly rich in the fossils of the London Clay from the north side of London; and Dr. Bowerbank's more general collection possesses some choice and unique specimens. To Mr. Prestwich I am further indebted for some of his typical specimens, and more especially for his assistance in regard to localities. Neither must I omit to mention that our national museums contain many specimens that have already been used for the illustration of the Bivalves of these older Tertiaries, or which will materially contribute to that object; and I beg to express my obligations to the conservators of these treasures, who have in the most handsome and friendly manner given me every possible facility and assistance in the promotion of my undertaking. The utmost desire of every one connected with Palæontology appears to have been shown to assist in forwarding the good work undertaken by the Palæontographical Society.

S. V. WOOD.

March, 1861.

B I V A L V I A.¹

INTRODUCTION.

THE BIVALVIA constitute the third portion of the still greater division of the animal kingdom called Mollusca, from the word *mollis*, a term that might by hypercritics be considered objectionable, conveying as it does an erroneous impression, the exterior covering of these animals being in most instances particularly hard, more so than the internal skeleton of the Vertebrata. Bivalves are acephalous, or animals without a head, but they are furnished with a (generally) large and powerful mass of flexible material, called a foot in consequence of its being the principal organ of locomotion ; this is of importance to the Palæontologist, inasmuch as the opening or sinuated edge of the valves at the margin is modified by the magnitude of this foot. It is supplied with circular fibres for extrusion, and longitudinal fibres for retraction. Although some of these animals are capable of changing their places

¹ In the second volume of the 'Crag Mollusca' the word "Bivalvia" is employed for those animals that are without a head, and are enclosed within two valves or pieces of calcareous covering, and it is repeated here for the same group. This name appears to me to possess the greatest claim on account of its priority of date, and it is most expressive in its application. An objection has been made to it, that it does not include the Brachiopoda, which are also enclosed within two valves, but the same want of isolation may be urged against the rival claims of Acephala, Conchifera, and Lamellibranchiata. The meaning of each of these names is not restricted to the characters of the animals they are intended to represent, and the advantages they offer are not, in my opinion, sufficient to entitle either to supersede the earlier name of Bivalvia. The Committee of the British Association, in their 'Rules and Regulations for Nomenclature' proposed in the year 1842, and recommended that "The law of priority should be admitted as the only effectual and just one," but that it should not extend to authors anterior to Linnæus (ed. 12th, 1767). The adoption by me of the above name is in compliance with those recommendations.

of abode, many remain all their lives in a stationary condition; some are moored by a cable or byssus, secreted for that purpose, by the foot; others are located in an excavation which is formed when young, and gradually enlarged to supply the increasing wants of the growing animal. In regard to magnitude, they present a large amount of variation; the adult shell of *Erycinella ovalis* is less than a line in its greatest diameter, while a specimen of *Tridacna gigas* in the museum at the India House has a longitudinal diameter of four feet, giving a difference of more than five hundred in linear dimensions; and the weight of a united pair of valves of *Kellia pumila* is a fraction of a grain, while *Tridacna* is said, with its animal, to exceed six hundred pounds, and these extremes, though not quite equal to those of the Vertebrata, do not fall very far short of them.

Bivalves in the early period of the world's existence constituted a much larger proportion of the Mollusca than the Univalves (if that designation be confined to the Gastropoda), although much inferior in number to the Brachiopods. In these proportions, however, very considerable alterations take place as we approach the present time, in which the Bivalves are in the minority compared with the Univalves, but largely in excess of the Brachiopods, the Univalves appearing to have taken the place of the Tetrabranchiate Cephalopods, which were extensively developed during the earlier and middle periods, but have now, with the exception of one genus, disappeared. The Brachiopods materially diminish while the Bivalves as steadily increase up to the Tertiary periods; and although collectively the Bivalve species that have lived, but are no longer in existence, exceed in number those of the present day, yet at no single period will they bear a comparison with existing species until we approach the older Tertiaries, their proportions during that period being not very different to what they are at the present day, if we take into consideration the comparatively limited areas that have been examined in search of fossils.

Bivalves succeed the Univalves in a natural arrangement, the latter being more highly organized, having an imperfect head with eyes more or less developed;¹ the former have, however, a mouth and digestive apparatus deeply inclosed within the mantle and its calcareous covering. According to Drs. Carpenter and Bowerbank, the shell is formed by the secreting action of the epithelial cells covering the mantle of the animal, and it is enlarged solely by the increase to the margin of the shell, that is, by a rib or band of shelly matter being added to the external edge of the previously formed shell. The mantle or cloak which envelops the viscera, though not the most vital organ, is the most important one to the Palæontologist, as by this the shell is formed, and on this the shell is moulded, and the species is determined by what this mantle has deposited. This calcareous covering is exceedingly variable in its composition and solidity; in some species the animal appears to possess the power of secreting a large amount of mineral matter, in others the shell is particularly thin and semi-transparent; in some it is of

¹ Species in the Genus *Pecten*, as also some in the Genera *Arca* and *Pectunculus*, have the margin of the mantle studded with spots, "ocelli," and these are said to be rudimentary eyes, but they are very imperfect organs of vision.

enormous thickness, highly calcareous, and with only a small cavity for its inhabitant, while in others the shell is nearly corneous, and in some the soft parts, as they are called, constitute almost the entire animal, the mantle having but a very thin coating of calcareous matter.

Marine shells, as a general rule, are thicker than those which inhabit fresh water, but in both the variation is occasionally excessive. *Ostrea* and *Pholadomya* may be cited as examples of the extremes of thickness and tenuity in the case of marine Bivalves; *Unio* and *Cyclas* in those of fresh water. In all these cases, solidity or tenuity of substance does not appear to have been regulated in the animal solely by the want of a protective covering as a preservative to its specific existence.

Fresh water Bivalves, like the Terrestrial air-breathing Univalves, do not exhibit the great specific variation that we see in marine animals of the same class. We might naturally expect this to be so in regard to shells inhabiting fresh water, when so small a space is occupied by these animals in comparison with that on which their marine congeners live, but why the land Pulmonata should in specific enumeration be inferior to other Mollusca is not by any means satisfactorily explained; the bands round the coast lines which contain nearly the whole of marine Molluscan life being far more limited in their dimensions than the feeding-ground occupied by the Pulmonata, which may be taken as the chief part of the land area generally.

The headless animals which compose this group, or the division of it called the Dimyaria, are nourished and sustained by two siphonal tubes, formed by a prolongation of the mantle, the one inhalent, and the other exhalent; the former being that through which the water containing the particles of nutrition is conveyed to the mouth, and for aërating the branchiæ, and the latter that which carries off the water after this duty has been performed. The animals which are furnished with these prolongations are necessarily supplied with muscles for their extension, as also for their retraction; and as a considerable space is required for the play of these tubes, an impression is generally formed by the retractor muscles upon the interior of that part of the valve, indicating the length or extent to which they are or have been capable of protrusion, and the depth of the sinus in general corresponds with the presumed extent of the siphons.

Bivalves are all aquatic, and breathe entirely by means of gills or branchiæ, and these consist usually of four riband-shaped lamellæ, two of them attached to each lobe of the mantle; water, therefore, is in their case necessary to sustain life; a few species, however, appear to be able to retain a sufficient quantity of moisture to enable them to live for a considerable time out of water. Shells often acquire an increase of material where there is a superfluity of lime within their reach, and become too ponderous for any apparent requirements of the animal.

Most shells in the living state are covered with an outer pellicle or coating, called the epidermis, a material more animalized, that is to say, there is less of lime in its composition, and therefore, under ordinary circumstances, less capable of preservation

in the fossil state. This is also exceedingly variable, being thick and opaque in some species, while in others it is thin and transparent, and in many glossy and polished shells it is entirely absent. The epidermis is said to be a protection to the shell against the chemical action of acids held in solution by the water; but many fresh- and salt-water species, although covered with a thick and woolly epidermis, suffer materially by the erosion of the shell, while those that are less protected by this covering appear to escape altogether. It is at the umbones, or that part of the shell which is most remote from the more vital portions of the animal, and in those species which appear to contain a less quantity of animal matter, that the ravages are committed. In some glossy and polished shells, such as in the Venus tribe, there is a total absence of epidermis, and these do not suffer from erosion.

The two valves are held together by an elastic ligature: this has been called *ligament* when it is situated on the external part of the shell, and *cartilage* when it is internal; but as this fastening is sometimes composed of a portion of each, we are on those occasions unable to characterise it by either of those terms *alone*, and I think it ought to have a peculiar name for its joint and general service; I propose, therefore, to call it *connexus* (the connector). When this ligature is external, it acts over a support or fulcrum, and by its elasticity contracts in order to open the valves; it is then *ligamentous*. When it is placed within the outer margin of the shell, it is *cartilaginous*, opening the valves by its expansion; and when it partakes the double character of ligament and cartilage, it is *amphidesmous* or *bipartite*. This elastic material is then extended both outwardly and inwardly, and although in this case the ligament and cartilage are united, there is always a slight elevation or partition between them, and this forms the fulcrum over which the ligament acts. The two pieces of the Bivalve are thus naturally kept open by the elasticity of the ligamentous portion in its contraction, and by the cartilaginous in its expansion, and when the two valves are closed in the living animal it is by the contraction of the adductor muscles. In the fossil state Bivalves are of course often found in their natural position, that is, with the margin of the valves separated in the way the dying animal has left them on the relaxation or rather paralysis of the muscles, but the two valves are as often quite closed; this, of course, must be from external pressure overcoming the action of the *connexus*.

Although the two valves are kept together and held in position by the *connexus*, they are often further secured by prominent processes, called teeth, which prevent a lateral motion; these are said to be strong and prominent where there is weakness in the *connexus*, and, as a general rule, amongst the Dimyaria the observation is more applicable to those shells where it is on the outside (*i. e.* ligamentous), while in *Mya*, *Anatina*, &c., which have the *connexus* internal (*i. e.* cartilaginous), there are no prominences or teeth. This rule, however, like most others, is not without exceptions; *Nucula*, *Leda*, *Macra*, &c., have the dorsal margins furnished with numerous and prominent interlocking teeth; perhaps, as a general rule, the more locomotive species have the strongest hinge. The dental apparatus, in

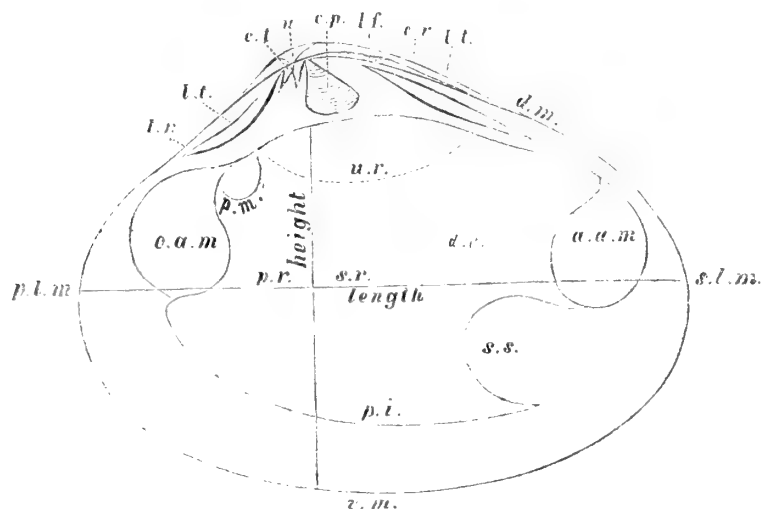
conjunction with the *connexus*, constitutes the hinge on which the valves open and close. The *Brachiopoda*, which have also two valves, differ from *Bivalvia* in wanting the connecting ligament, and the opening as well as the closing of the valves is in that class effected by muscles; they differ also in having one valve perforated, through which the byssus passes, and as this opening is enlarged during the growth of the animal, the infant state of that perforated valve is *entirely* destroyed, but the infant state of the *Bivalvia* is visible in both valves at all ages in the umbonal region of the adult shell.

The adductor muscles of the *Dimyaria* are generally of the same magnitude, or at least nearly so; where there is a difference, it is in those animals whose shells are greatly inequilateral, the larger portion then requiring somewhat greater power in closing the valves. The pedal and siphonal regions are easily known in most species, even in the equilateral or orbicular shells, by the position of the *connexus* when it is only on one side of the umbo, as in that case it is always more or less on the siphonal side, even in those shells where it is wholly internal or cartilaginous; but in genera, such as *Pectunculus*, *Limopsis*, and the equilateral *Arca*, which have the *connexus* spread over a large area equally on each side of the umbo, it is by no means so readily determined. The siphonal region may, however, be generally recognised by the impression of the anal adductor being somewhat higher up, permitting the openings for the incoming and outgoing currents to pass beneath it, and the oral adductor is slightly prolonged by the union of the pedal muscle, which in these animals is required to move their large and expansible foot.

The Bivalve shell has always been described as having an anterior and a posterior extremity, and it would be desirable still to retain that general description, if it were not for the diversity of opinion there always has been, and which still exists, amongst conchologists, as to which should be considered the anterior and which the posterior portion of the animal. It is at times difficult to determine, in descriptions, which is intended by the author as the anterior, and which as the posterior, for these terms are sometimes employed conversely. I believe the animal in its shell will sufficiently denote the anterior and posterior of itself by the position of the mouth and anus, as in all animals where these are separated the first is considered anterior and the last posterior; but in the *Bivalvia* it is said by those who advocate the reverse of this, that the indrawing tube of the animal by which nutriment is conveyed to the palpi, and thence to the stomach, is on that part which by some is called posterior, but which ought, on that account (they say), to be called the anterior, and also that this portion, in all boring Bivalves, for example, is always the uppermost or anterior in their retreat.

I have therefore thought it expedient in this monograph to substitute for these terms an alteration by which, it is hoped, the confusion may be avoided. That which I have called the pedal region ought perhaps, more strictly speaking, to be considered as the buccal region, and the opposite one the anal, but the Palæontologist is more especially concerned with the shell and its interior, which bears the impress of the muscles only, and not of the viscera, or at least very rarely so. I have thought it better to employ those

terms with which the conchologist, rather than the malacologist, is most familiar; I therefore introduce a figure with a formula of explanation, making as little alteration in existing terms as possible.



u. Umbo.
u. r. Umbonal region.
p. r. Pedal region.
s. r. Siphonal region.
l. r. Lunule region.
c. r. Corslet region.
d. m. Dorsal margin.
v. m. Ventral margin.
p. l. m. Pedilateral margin.
s. l. m. Siphonilateral margin.

c. p. Cartilage pit
l. f. Ligamental fulcrum } *connexus*.
p. m. Pedal muscle.
o. a. m. Oral adductor muscle.
a. a. m. Anal adductor muscle.
p. i. Palleal impression.
s. s. Siphonal sinus.
c. t. Cardinal teeth.
l. t. Lateral teeth.
d. r. Depth of valve.

A considerable difficulty exists in the mode of estimating the dimensions of a Bivalve, from the want of accordance amongst conchologists in denominating the different parts of the shell, the length being sometimes considered to extend from the umbo to the ventral margin, the breadth from the pedilateral to the siphonilateral margin, and the most tumid portion of the closed valves as forming its height. At other times it is the reverse of this. In my monographs I have adopted the latter method, conceiving it to be the more natural one. The base on which the animal stands is the ventral margin, and on which it is moved by the foot in all those which are locomotive; therefore the height should be from that base to the vertex or umbo, and the length consequently should be taken in an opposite direction, while the tumidity of the valves may be considered the depth, and the substance of the shell its thickness.

In the Dimyaria, which are generally transverse shells, and have a greater diameter from the pedal to the siphonal region, there is no difficulty in thus considering these various dimensions; but with the orbicular shells, or with those whose elongation is from

the umbo to the ventral margin, such as *Lima*, *Vulsella*, *Ostrea*, &c., we are much perplexed with the application of these terms, as we meet sometimes with a shell whose height will exceed the length two or even threefold, and the longest diameter in that case is in ordinary parlance called the length, and this is often so employed by those who estimate generally the length of the Bivalve from the pedilateral to the siphonilateral margin. The same terms ought in our descriptions to be employed for such shells as *O. Virginica*, as is done to those like *Solen*, &c., where the longest diameter is in an opposite direction.

The older Tertiary species of England are, I believe, with a very few doubtful exceptions, all extinct, but they have a generic representation among existing forms. This, of course, must depend upon what is to be accepted as sufficient for a generic distinction.

A genus is said to consist of a group of species related by community of structure and parts comprehending all essential characters. In Bivalves the *number* and position of the hinge-teeth, as also the position of the connexus, whether external or internal, are considered by some authors sufficient, when separately estimated, to characterise a genus; while others will regard some of these distinctions as unimportant, or, at least, of only specific value.¹ The definition of a species is equally unsatisfactory; it has been given in the following formula:—"All specimens or individuals which are so much alike that we may reasonably believe them to have descended from a common stock (parent or parents), constitute a species." It is, however, found in the practical examination of individuals that the line between these groups is generally so ill-defined that we are led to doubt whether there is in nature any such distinction as we find it convenient to make in order to suit our own purposes. Great authorities say that "no general rule can be laid down for determining the distinction of species, as there is no particular class of characters which can serve as a criterion. In each case we must be guided by *analogy and probability*." It thus appears that our determination is mainly dependent upon individual opinion, and we have nothing whereby it can be decided that the conclusion of any author is the correct or real one. Those only who have laboured hard to fix the limit of a species out of a multitude of specimens, of similar or proximate forms, can tell the uncertainty attending the determination of such a distinction, and the unsatisfactory conclusion at which the naturalist often arrives; and when the varying opinions of preceding authors are weighed

¹ In order to show the difficulties which exist in characterising such a section, we may take the Genus *Lucina* as an example. This Genus, as admitted by several modern authors, contains shells possessing differences which, in other portions of Bivalvia, are considered as being in themselves separately entitled to generic distinction. Thus, *Lucina* comprises: 1st, shells without hinge-teeth; 2dly, shells with cardinal teeth only; 3dly, shells with one lateral tooth; 4thly, shells with two lateral teeth. This genus also contains species in which the connexus is both outward and inward: 1st, those in which it is wholly external, with a thick and solid shell, such as *L. columbella*; 2dly, those in which it is amphidesmous, with a thin and almost diaphanous shell, such as *L. flexuosa*; 3dly, those in which it is situated internally, opening the shell by expansion, as in *L. lactea*; besides these differences, some species are perfectly plain and free from sculpture, while others are beautifully ornamented, and the animal also partakes of the varying characters of the shell.

and critically examined by their successors, we are so much nearer a successful decision only by a more general concurrence of opinion in favour of one set of determinations than of the other.

The duty of the Palæontographer is to give good figures and copious descriptions, in the hope to secure similar determinations by the largest number of these naturalists who have well studied the intricacies of the subject, and thus to afford a test by which those who succeed may gauge and determine the value of his conclusions.

The difficulty which, in the course of my study of the Mollusca, I have frequently encountered in assigning the true specific value to forms which, in a series of individuals, exhibited such an approximation to other forms called specifically distinct, long since raised in me a doubt of the reality of specific distinctions as a fact in nature, which reflection upon the general nature of organisms matured into a conviction that all organisms originated by a natural process of slight variation accumulating in a given direction out of other and pre-existing organisms. I was therefore, fully prepared for the enunciation of the theory of Mr. Darwin, that all forms have originated by selection, and I readily concede that process to be one of the most powerful, if indeed it be not the sole cause of all the varied forms of being that have peopled the earth. Nevertheless, specific distinctions, empirical or artificial though they may be, must always be to a certain extent recognised as essential to the proper working out of our knowledge of Palæontology, and particularly to a correct apprehension of the true ages of geological formations, and of the reduction of those widely severed in area to a common horizon. The general recognition, however, of such an origin for organisms, if indeed that ever be conceded by reluctant Palæontologists, will, in addition to the importance of the discovery of so great a truth, be no little boon to the hard-working naturalist, whose labours have been seriously aggravated by a desire for species making.

It is intended here to describe all the species of British Bivalves belonging to the Eocene or older Tertiaries of England; these, with the Crag and overlying deposits, constitute the Tertiary remains in this country.

The great Eocene Formation in England has been separated into ten distinct series of deposits, viz., the Bembridge, Osborne, Headon, Barton, Bracklesham and Bagshot series, the London Clay, the basement bed of the London Clay, the Reading and Woolwich series, and the Thanet Sands. These divisions are based principally upon geological and lithological evidence. I have not been able to characterise these various distinctions by their organic contents, but have merely introduced the localities of the different species so far as they are known to me.

The Marine Fauna of the Eocene Deposits appear to have their connexion with the existing types of the eastern seas, where several of the Eocene genera are only now to be found; this is rather more strongly displayed by the Cephalopoda and Gasteropoda than by the Bivalves, although in this latter division we have not less than seven genera now confined to seas lying south-east of this country, viz., *Vulsella*, *Cucullæa*, *Cardilia*,

Fimbria, *Thetis*, *Cultellus*, and *Limopsis*.¹ In the higher group of Mollusca as many as twelve genera may be enumerated, viz., *Nautilus*, *Pterocera*, *Scraphs*, *Harpa*, *Metula*,² *Borsonia*, *Rotella*, *Pyramidella*, *Niso*, *Nematura*, *Phorus*, and *Parmaphorus*, also now confined to the south-eastern seas, and these genera appear to represent a relationship to the Marine Fauna of the Eocene period more especially than any others I can instance.

The land and fresh-water species have, I think, on the contrary, retired in an opposite direction, as their connexion appears to be more especially with the existing types of the American Fauna. Mr. Edwards has described fifty-seven species of Pulmonata from our Eocene Deposits, of which only ten, he considers to be identical with fossil species of the European Continent, and this I imagine arises from a difference in the direction of the rivers which flowed into the Paris Basin Sea, and which were quite distinct from the one that is presumed to have been emptied into the Hampshire Beds.

The Bivalves now to be described comprise species of fresh-water animals as well as those from estuarine and marine deposits of the great Eocene Formation in this country. The estuarine animals were, no doubt, shallow-water species, and the principal part of the marine from the littoral or sub-littoral zones; the deep-water portion of the period being, in all probability, the great Nummulitic deposit. We are able, in some degree, to surmise the probable depth of the sea of a marine deposit, from the collective indications of the various genera it contains, whose habits are presumed to be similar to those of existing analogues, but even in these suppositions extreme caution ought to be observed. The dredgings of Mr. M'Andrew and others, among existing Molluscs present us with anomalies, which show that in some genera, as, for example, in *Chiton*, *Trochus*, &c., which generally inhabit the littoral zone, species have presented marked exceptions to this rule, as they have been found alive in deep water only. A conclusion, therefore, drawn from a *single* extinct species can not be entirely depended upon, inasmuch as the habits of the animal might have resembled those of the exceptional cases in existing genera.

¹ This genus has one species living in the Red Sea, one at Singapore, one off the Cape of Good Hope, and one (perhaps two) have been found in the North Seas. These last are probably the prolonged existence of the Crag species; otherwise the generic relationship is with the south and east.

² Mr. P. Carpenter has, in his valuable 'Report on the Mollusca of the West Coast of North America,' introduced four species, but the generic name is accompanied by a mark of doubt.

ANOMIA. *Linn.*, 1767.¹

Generic Character. Shell inequivalved, irregular and variable, subequilateral, ovate or suborbicular, and slightly pearly within; upper or left valve convex, smooth, lamellar, striated, costated or muricated; lower valve flattened, sometimes very slender, with a large foramen, through which passes a calcareous appendage, or calcified byssus, for the attachment of the animal. One muscular impression in the lower or fixed valve, and four in the upper. Connexus cartilaginous; hinge edentulous.

Animal unsymmetrical, with the edges of the mantle disconnected, except at a small spot near the hinge; its margin double, slightly fringed, without ocelli or rudimentary eyes; foot very small, cylindrical, expanded at the end, and grooved; byssus large, passing through a nearly complete foramen in the right mantle lobe, and attached by a powerful muscle to the centre of the left valve. One adductor muscle; palleal line continuous. Sexes distinct.

The impressions of four muscles are left upon the interior of the upper or left valve; one of the four is that of the adductor, and is the only one impressed upon both valves. The largest of these muscle-marks is the attachment of the byssal plug; probably the two centre marks belong to that organ, and the small one in front of the cartilage-pit is caused by the retractor of the foot. The animal cements itself to the rock by the byssus, which contains so much calcareous matter that it becomes as hard as the shell itself, and this plug is found in the fossil state in the upper, though I have not yet seen it from the lower, Tertiaries.

The right or adherent valve is very thin, oftentimes almost obsolete, and in some species it is much less in size than the upper, so that the mantle extends considerably beyond the edge of the shell, showing the lower valve to be almost useless; the perforation of this valve in some species is very large, with an unconnected margin; indeed, this is the more common character. The cartilaginous connexus is placed on a projecting piece of this valve, behind which the shell is thickened with a sort of double ridge running into the body of the valve; this is often the only portion preserved in the fossil state, and I now find that to have been the condition of the little Crag fossil, which I imagined to have been the internal shell of a Gasteropod, and figured in the 'Crag Mollusca,' doubtingly, under the name of *Aplysia*.

The umbo of the upper valve in some specimens of this genus is removed to a considerable distance from the margin of the shell, and in its exterior makes, in appearance, an approach to the limpets. The large and extended muscle-marks of the interior

¹ For generic synonyma see 'Crag Mollusca,' Part "Bivalves."

also resemble the impression of the adductor in some of the capuloid shells, more especially those of the Genus *Hipponyx*, in which the animal constructs a shelly base resembling a second valve, and the adductor in that Gasteropod has the twofold purpose of the Bivalve muscle, adhering to the shelly base as well as to the interior of the conical shell, forming and leaving a similar mark deeply impressed upon the inner surface of each piece, the muscle extending itself behind the foot, and this otherwise large "belly-foot" of the *Hipponyx* is contracted to permit it to take hold of the shelly base. These impressions in *Anomia* indicate the presence of powerful muscles, although the animals possess little more than the rudiments of a foot. The genus is far removed from those animals which have only one piece of shell (the Univalve), but they are perhaps nearer than any other Bivalves, and they are, I think, appropriately placed here at the head of the list.

In the recent state, this genus has an extensive geographical range, species belonging to it are found in America, India, Australia, the Mediterranean, and the North Seas. It is not numerous in species, either as recent or fossil.

1. ANOMIA TENUISTRIATA, *Deshayes*. Tab. IX, fig. 1, *a—c*.

- ANOMIA STRIATA. *J. Sow.* (non striata, *Broc.*, 1814). *Min. Conch.*, t. 425, 1823.
 — — *Galeotti*. *Mém. Cour. par l'Acad. Brux.*, t. xii, p. 151, No. 89, 90.
 — EPHIPIUM. *Defrance*. *Dict. des Sc. Nat.*, t. 2, 1823.
 — TENUISTRIATA. *Desh.* *Coq. Foss. des Env. de Par.*, t. 1, p. 377, pl. 65, figs. 7—11.
 — — *Sow.* In *Dixon Geol. of Sussex*, p. 117, t. 4, fig. 8; and t. 14, fig. 17, 1850.
 — — ? *Grateloup*. *Cat. des An. du Bas de la Gironde*, p. 56, 1838.
 — LÆVIGATA? *Nyst*. *Coq. Foss. Belg.*, p. 311, pl. 26, figs. 4—6, 1843.
 — ORBICULATA? *Id.* - - - p. 312, pl. 25, fig. 6, *a, b*.
 — LINEATA. *J. Sow.* *Min. Conch. Syst.*, index, 1835.
 — — *Morris*. *Catal. Brit. Foss.*, p. 161, 1854.
 ANOMIA TENUISTRIATA. *D'Orb.* *Prod. Palæont.*, p. 395, No. 1148, 1850.
 — SUBSTRIATA? *Id.* - - - p. 396, No. 1150, 1850.
 — SUBLÆVIGATA? *Id.* - - - p. 396, No. 1149, 1850.
 OSTREA ANOMIALIS. *Lam.* *Hist. des An. sans Vert.*, t. vi, p. 220, 1822.

Spec. Char. *A. testá tenui, suborbiculari, irregulari, valdè inæquivalvi, valvâ superiore convexâ, tenuissimè striatâ, valvâ inferiore planâ foramine magno; umbone submarginali.*

Shell thin, irregular, rounded, and finely striated externally; upper valve much the larger and convex; lower valve small, flat, and thin, with a very large opening for the plug; umbo near the margin.

Diameter, 2 inches.

Locality. Alum Bay, Barton, Bramshaw, Brockenhurst, Brook, Bracklesham, Bognor, Clarendon, Stubbington, Whitecliffe Bay (*Edwards*), Clewett's Green, Newnham (*Prestwich*), Highgate (*Wetherell*).

Belg., Env. de Bruxelles, Sables d'Uccle et de Forêt (*Nyst*).

France, Grignon, Montmirail, Senlis (*Desh.*), Blaye (*Grateloup*).

This, like most of the species in this restricted genus, is very variable, assuming a shape in some degree conformable with the place in which the individual has chosen to fix its abode; and although the generality of specimens have the upper valve convex, it occasionally happens that this valve is flat or even slightly concave outwardly; the form is sometimes elongately ovate, while at others it is elevated, but when quite free and not distorted it is nearly orbicular, as may be seen by the specimen figured, which displays its natural shape. The same habits existed in this animal as in species of the genus at the present day. One of Mr. Edwards's specimens adhered to the back of a *Pecten*, the markings and rays of which it has assumed with great regularity (fig. 1, *c*).

In the young state of this shell the striæ are wholly invisible, and, indeed, in some of the larger specimens they are only to be detected by a powerful lens; it is so in those from Clarendon, and this I imagine is the condition of those specimens to which the names of *A. lævigata* and *A. orbiculata* have been given. The muscle-marks in the upper valve are well displayed; the larger one, the muscle of the plug, is situated under the cartilage-pit, and is more than double the size of the adductor, and corresponds with the large foramen of the lower valve; the shape of this mark is modified by the shape of the shell; the upper pedal impression is close to the corner of the cartilage-pit, and I had imagined at one time that a difference in form existed between the specimens from Clarendon and those from Barton, but apparently this is not a permanent character, and these markings are all variable in outline. In the specimens from Grignon the same variableness in these muscle-marks may be observed; they assume, in a great degree, a shape much in accordance with the outward form of the shell. I am unable to detect a difference which might fairly be considered specific between any of the specimens, from the lowest to the uppermost of the older Tertiaries through which this *Anomia* extends. The umbo or beak of the shell is likewise an unstable character; in some specimens it is immediately on the margin, while in others it is at a little distance from it, and Mr. Sowerby says ('Min. Conch.', p. 32) that the shell, when old, is contracted towards the beak, but this condition is probably accidental, as it occurs only in some specimens.

Barton specimens seldom exceed an inch in diameter, while those from Bracklesham are double that size. I have seen only a few from Clarendon, and those were small. The shell is generally more or less tinged with a reddish-brown colour, particularly the Bracklesham specimens, and probably contained a good deal of animal matter. This species ought strictly to be called *A. anomialis*.

2. ANOMIA SCABROSA, *S. Wood*. Tab. XI, fig. 5, *a—c*.

Spec. Char. *A. testâ minutâ, orbiculatâ, compressâ, tenui; valvâ superiore costulatâ vel radiatâ, et valdè imbricatâ, imbricibus magnis et regularibus; valvâ inferiore planulatâ; foramine parvo.*

Shell small, orbicular, somewhat compressed, thin; upper valve costated or radiated, with large and elevated imbrications; lower valve with a small opening.

Diameter, $\frac{1}{4}$ of an inch.

Locality. Hampstead (*Edwards*).

Two or three specimens are all that I have seen. The imbrications upon the upper valve are large and elevated, presenting a very rough exterior, resembling the surface of a blacksmith's file. The lower valve shows the round foramen to be on the left side of the umbo, from which I presume the exposed surface to be the interior of that valve.

We have thus in these older Tertiaries the prototypes of the striated and imbricated recent British species, only in excess, the one more roughly imbricated, and the other less coarsely striated.

OSTREA. *Linn.*, 1685.

Generic Character. Shell attached by the larger or lower valve, generally thick and strong, lamellated or foliated, variously shaped, irregular, inequivalved, inequilateral; upper or free valve flat or slightly concave; under valve convex, sometimes strongly marked with radiating, lamellated costæ; hinge without teeth; connexus ligamentous lodged in an elongated, triangular depression in each valve. Impression of the adductor muscle large, subcentral, that formed by the mantle entire, generally indistinct and ill-defined.

Animal with the mantle-margin double, or disunited; its edges bordered by short, tentacular fringes; foot obsolete. Sexes distinct.

The oyster fixes itself by the outside of the left valve, and as this is done generally upon a horizontal support, the valves, from that position, are called upper and lower, and although they are unsymmetrical and inequivalved, they are nevertheless bilateral, and have a right and left valve like the *Dimyaria*. Oysters are generally gregarious animals, although some species appear to be solitary. *Ostrea folium*, an Oriental species, secretes projecting processes or fingers, which extend from the back of the lower valve, and by which it clasps the roots and branches of trees which grow into the water, from which habit it was called *Dendostrea* by Swainson. This, of course, is done when the animal is young, or only so long as the edge of the mantle can be extended to the extremity of the processes, after which they cannot be prolonged. Some oysters are peculiarly prone to secrete a large quantity of lime, particularly where that material is abundant; and a fossil oyster from the banks of the Tagus has been found with its lower valve two feet in its longest diameter, and of a proportional thickness. The oyster, in general, is adherent in the younger state, but when it has grown large and heavy it ceases to increase the attachment, and enlarges the shell, like a free Mollusc. Some species adhere only by a very small portion of the shell, while others are attached by nearly the whole of the outer surface of the lower valve; this character is, however, variable, even amongst individuals of the same species. The genus inhabits salt water, although the common edible oyster will live in rivers in England where the water at low tide is nearly fresh.

The age of the oyster is probably various in different species; *O. edulis* is said to live

about ten years, but to come to perfection in four or five. Fishermen pretend to be able to tell the age of this Mollusc by the discoloured fimbriations upon the lower valve, somewhat like the hybernating marks upon the snail.

1. *OSTREA ADLATA*, *S. Wood*. Tab. V, fig. 3, *a—c*.

Spec. Char. *O. testá minimá, ovato-elongatá vel irregulariter cuneatá, apice obliquo; valvâ inferiore radiato-costatâ, plus minusve profundâ; valvâ superiore planiusculâ vel convexiusculâ; marginibus supernè granoso-plicatis; impressione musculari sublunari.*

Shell small, ovately oblong, or irregularly wedge-shaped, apex oblique; lower valve radiately costated, more or less deep; upper valve flat or convex, margin near the hinge crenately plicated; muscular impression sublunate.

Longest diameter, 1 inch nearly.

Locality. Hempstead, Isle of Wight (*Edwards*).

There is something peculiar about this little shell which seems to entitle it to an isolated position, and I have, in consequence, given it a new name. It is a miniature representation of *O. flabellula*, but the costæ are fewer and do not appear to be visible in the young shell. All the specimens I have seen are attached to *Cerithium plicatum*; this, perhaps being the most abundant univalve in the deposit, has been selected for that purpose, and the oyster has sometimes fixed itself in the direction of the height of the univalve, by which it has become elongated from the umbo to the ventral margin, and has thereby altered the natural form of the shell. In one or two specimens the costæ are obsolete or scarcely visible, and the margins of the valves near the hinge appear to have interlocked; having crenulations in the right valve corresponding with depressions in the left for their reception. The cylindrical support of the animal has not only reduced the depth or capacity of the lower valve, but this internal prominence has communicated its form to the upper valve, making it very convex. It is similar in habit to *O. mutabilis*, *Desh. Coq. Foss. des Env. de*, p. 344, pl. 56, f. 9-10, but that species does not appear ever to have had its lower valve plicated.

2. *OSTREA ALIENA*, *S. Wood*. Tab. VIII, fig. 2.

Spec. Char. *O. testâ tenui, ovatâ vel ovato-rotundatâ, valvâ inferiore convexiusculâ, extûs irregulariter costulato-radiatâ, sub-lobatâ.*

Shell thin, ovate or ovately rounded; inferior valve slightly convex, and covered with radiating ribs or riblets, and slightly lobed.

Diameter, 3 inches.

Locality. Bracklesham (*Edwards*).

There are a few specimens of *Ostrea* in Mr. Edwards's cabinet, which I cannot satisfactorily assign to any species known to me, and I have given to them the above name provisionally.

The principal distinction is the thinness of the shell and the smallness of the hinge-area, with rather small and distant ribs in which characters, as well as in the form of the muscle-mark, it seems to differ from the young of *O. Bellovacina*, to which it otherwise somewhat approaches. I have not seen the upper valve.

3. OSTREA BELLOVACINA, *Lamarck*. Tab. III, fig. 1, *a*, *b*, and Tab. VII, fig. 3, *a—c*.

OSTREA BELLOVACINA.	<i>Burtin</i> . Oryct. de Brux., pl. 10, figs. <i>a—d</i> , 1784.
— —	<i>Lam</i> . An. du Mus., t. viii, p. 159; and t. xiv, pl. 25, fig. 1, <i>a</i> , <i>b</i> , 1806.
— —	<i>J. Sowerby</i> . Min. Conch., t. 388, figs. 1, 2, 1823.
— —	<i>Deshayes</i> . Coq. Foss. des Env. de Par., p. 356, pl. 48, figs. 1, 2; pl. 49, figs. 1, 2.
— —	<i>Goldf</i> . Petr. German., t. 11, p. 15, pl. 77, fig. 2.
— —	<i>Nyst</i> . Rech. Coq. Foss. de Hoesselt and Kl. Sp., p. 16, No. 41, 1836.
— —	<i>Nyst</i> . Coq. Foss. Belg., p. 318, pl. 30, fig. 1, <i>a</i> ; pl. 31, fig. 1, <i>b</i> ; pl. 32, fig. 1, <i>a</i> ; pl. 33, fig. 1, <i>b</i> ; 1843.
EDULINA, <i>Lam</i> .	<i>Hist. des An. sans Vert.</i> , t. vi, p. 218, 1822.
— —	<i>J. Sowerby</i> . Min. Conch., t. 388, figs. 3, 4, 1823.
— UNDULATA ?	<i>J. Sow.</i> (non <i>Nyst</i>). Min. Conch., t. 238, fig. 2, 1819.

Spec. Char. *O. testá ovatá, depressiusculá, valvá inferiore convexá, radiatim et rugosè costatá, et squamoso-foliaceá; valvá superiore planatá, obsoletè radiatá; concentricè lamellatá; impressione musculari mediocri, ovato-semilunari; umbonibus subæqualibus.*

Shell ovate, rather depressed, lower valve convex, with rugose, radiating ribs or ridges, foliations squamose; upper valve nearly flat, and obsoletely ridged by lamellated lines of growth; muscular impression of a moderate size, ovately lunate; umbones nearly equal.

Longest diameter, 4 inches.

Localities. Charlton, *var. a*, Dulwich, *var. β* (*Edwards*).

France, Hauteville, Beauvais (*Lamarck*).

Belgium, Kleyn-Spauwen, Hoesselt et Lethen (*Nyst*).

Oysters occur almost throughout the whole extent of the lower beds of the Eocene Formation in England, and all the specimens that have been found were for a long time considered by geologists as varieties of *O. Bellovacina*, and the geographical range assigned to this species extends from Clarendon, Pebble Hill, and Newbury, through Reading, to Northaw and Rochester, including within these outskirts the central portions of Woolwich, New Cross, &c. On expressing an opinion to my friend, Mr. Prestwich, that there were two species found in these lower beds, and my wish, if possible, to have them separated, and their proper localities assigned, and requesting his assistance for that object, I learnt from him that he had, since the publication of his paper, strongly suspected that the

numerous shells united under the name of *Bellovacina* in the lower London Tertiaries belonged to more than one species. I had hoped to have been able to assign to these their respective localities, of which not less than twenty are recorded; Mr. Prestwich fears that, without a re-examination of the ground, this cannot be satisfactorily done.

The costæ in the *upper* valve of our shell are visible in most of the specimens found at Woolwich; these may also be observed in some from Beauvais, although in the generality of specimens from this latter locality they are obsolete. Tab. VII, fig. 3, *b*, has the upper valve quite free from these radiations, while in Tab. VII, fig. 3, *c*, another specimen from the same locality, they are very distinct. Differences quite as great, or even greater, may be observed in specimens of *O. edulis*. M. Hebert considers the shell from Kleyn-Spauwen, figured under this name, to be a different species, and says (Bull. de la Soc. Géol., 1848-9, p. 469, No. 7) that he has examined only the upper valve, and that this presents sufficient differences to entitle it to be specifically removed from *Bellovacina*; having seen only one valve, he refrains from giving it a new name. The shell represented by M. Nyst has distinct radiations upon the upper valve, but the muscle-mark seems rather more rounded than in the British fossil, which is reniform and somewhat pointed; the same may be said of the figure of the muscle-mark given by M. Deshayes from the Paris Basin; in a specimen I have from Beauvais, the muscle-mark precisely resembles those in the Woolwich specimens. I believe them to be the same species.

Philippi introduces this name as a fossil from Palermo, but he gives no figure, only a description, and this so short that it might be adapted to other species. In the Museum of the Geological Society is a specimen from Gibraltar much resembling our shell, but I think it is distinct; it has rather larger radiations, and these are more foliaceous. Sir Charles Lyell gives the name of *Bellovacina* to an *Ostrea* found in limestone at the "Grove," about seventeen miles north of Charleston, in South Carolina, 'Proc. Geol. Soc. Lond.,' February, 1845, p. 567, and I have seen a specimen, in Sir Charles's cabinet, from Virginia (without a name), which, in some characters, resembles *O. pulchra*; I can scarcely think it strictly identical either with it or with *Bellovacina*.

4. OSTREA CALLIFERA, *Lamarck*. Tab. V, fig. 1, *a*, *b*.

OSTREA CALLIFERA.	<i>Lam.</i>	Hist. des An. sans Vert., t. vi, p. 218, No. 19, 1822.
—	—	<i>Desh.</i> Coq. Foss. des Env. de Par., t. 1, p. 399, pl. 50, fig. 1; and pl. 51, figs. 1, 2, 1824—37.
—	—	<i>Id.</i> An. sans Vert. du Bassin de Par., t. 1, p. 110, 1860.
—	—	<i>Goldf.</i> Pet. Germ., vol. ii, p. 27, No. 71, pl. 83, fig. 2, <i>d—f</i> , 1833.
—	—	? <i>Nyst.</i> Coq. Foss. de Belg., p. 317, pl. 29, fig. 1, <i>a</i> , 1843.
—	—	<i>Bronn.</i> Lethæa Geogn., t. 39, fig. 14, 1836.
—	—	<i>Forbes.</i> Mem. Geol. Surv., 1856, pp. 46—145, pl. 1, figs. 5, 5, <i>a</i> .
—	HIPPOPUS?	<i>Lam.</i> Loc. cit. sup., t. viii, p. 159, No. 2, 1806 (non <i>hippopus recens</i>).

Spec. Char. *O. testā ovatā, hinc prope basim callo crasso subauritā; valvā majore*

crassissimá, intùs irregulariter excavatá; extùs lamellosá, valvâ superiore planá vel concavá; apice ad sinistram? arcuato; areâ ligamenti latá.

Shell ovate, with a projecting callosity on the opposite side to the curved umbo; shell thick, irregularly excavated; externally lamellated; upper valve flat.

Dimensions, 4 inches by 3.

Localities. Hempstead, Isle of Wight (*Forbes*).

Belgium, Pietrebais, près de Chapelle St. Laurent (*Nyst*).

France, Roquencourt, le parc de Versailles (*Desh.*)

This species, so far as I know, is in England confined to the upper beds of the older Tertiaries called the Hempstead series, and there it does not appear to be abundant. Its peculiar character is the callosity on the left or lower valve, caused by the broad adherence of the animal inclining to one side; this habit is retained until it is considerably advanced in age. The shell is thick and heavy; the umbo of Mr. Edwards's specimen (fig. 1, *b*) curves towards the siphonilateral margin, while the specimen from Jermyn Street (fig. 1, *a*) has the umbo in the opposite direction. This depends upon the mode of attachment in the young state, the umbo having been deflected by an impediment. The outer surface of the lower valve is irregularly rugose and coarsely laminated; the upper valve is much thinner than the lower, and flat, with the laminæ finer and closer.

An oyster from the Nummulitic Formation at Cutch is figured and described under the name *O. callifera* by Mr. Jas. Sowerby, 'Trans. Geol. Soc.,' vol. v, pt. 2, second series, pl. xxv, fig. 16. The Cutch specimen, which I have examined in the Museum of the Geological Society, does not, I think, belong to this species, and M. D'Orbigny, in his 'Prod.,' has named the shell *O. Sowerbyana*.

The upper valve of an oyster from Uffhofen in the Museum of the Geological Society is marked with this name, but it would be difficult to determine a species from that valve alone; the specimen is peculiar in being excessively thick, and it is perforated in the centre by the entire abstraction of the shell where the adductor muscle was attached.

M. D'Archiac gives this species somewhat doubtingly from the Nummulitic Beds in the environs of Bayonne.

5. *OSTREA CYATHULA?* *Lamarck*. Tab. VII, fig. 7, and Tab. VIII, fig. 3.

OSTREA CYATHULA. *Lam.* Ann. du Mus., t. viii, p. 163, No. 12, 1806.

— — *Desh.* Coq. Foss. des Env. de Par., t. 1, p. 369, pl. 54, figs. 1, 2; and pl. 61, figs. 1—4.

— — *Id.* An. s. Vert. du bassin de Par., t. ii, p. 114, 1860.

Spec. Char. O. "testá ovato-rotundatá, profundá, incrassatá, solidá; umbonibus magnis, posticè inflexis, aliquando contortis; valvâ majore subtilè plicatá, plicis angustis, distantibus, radiantibus, lamellis transversis interruptis; valvâ superiore planá, transversim striato-lamellosá, supernè crassá: impressione musculari semi-ovatá, transversá; fossula cardinali superficiali, transversim striatá."

Diameter, $1\frac{1}{2}$ inch.

Locality. Stubbington (*Edwards*).

In the beautiful work above referred to, now in course of publication by M. Deshayes, the author gives not less than three varieties of this species, and the British fossil does not differ in essential characters from one of the varieties of what is considered by the French author to be a very variable shell. I have, however, placed the British fossil under that name with a mark of doubt.

6. *OSTREA CYMBULÖIDES*, *S. Wood*. Tab. III, fig. 2, *a*, *b*.

Spec. Char. *O. testá ovato-oblongá, depressiusculá, valvâ inferiore radiatim plicatá, plicis rotundis, tuberculato-squamosis, subundulatis, bifidis; valvâ superiore planá; marginibus supernè crenatis.*

Shell ovately oblong, slightly depressed; inferior valve radiately plicated, with rounded, rough, or tuberculated and bifurcated rays; margin crenulated all round in the lower valve, with lateral crenations on the upper part of the flat valve.

Longest Diameter, $1\frac{1}{2}$ inch.

Locality. Herne Bay (*Bowerbank*).

Although this shell bears considerable resemblance to some of the forms of *cymbula*, it cannot satisfactorily be referred to that species, being more regularly ovate in outline, and more finely costated. It differs from *flabellula* in several characters, and it does not appear to have the tendency to angularity or prolongation which that species exhibits; it has also more numerous rays. *O. divaricata*, *Lea*, somewhat resembles this species, but that shell is more inflated on what, in the *Dimyaria*, would be the siphonal region, and there is also, apparently, a difference in the form of the muscle-mark; this in our shell is large, reniform, and somewhat pointed upwards, while in the American fossil it is semi-lunate.

The British fossil appears to be rare.

7. *OSTREA DORSATA*, *Deshayes*. Tab. VI, fig. 2.

OSTREA DORSATA. *Desh.* Coq. Foss. des Env. de Par., vol. i, p. 355, No. 22, pl. 55, figs. 9—11; and pl. 64, figs. 1—4, var. β ; pl. 54, figs. 9, 10.

— — *Id.* 2d edit., Lam., t. vii, p. 251, No. 42, 1836.

— — *J. Sowerby.* Min. Conch., t. 489, fig. 2.

— — *Id.*, in Dixon, Geol. of Sussex, p. 174, 1850.

— — *D'Orbigny.* Prod. de Palæont., t. 11, p. 395, No. 1139, 1850.

— — *Morris.* Catal. Brit. Foss., p. 174, 1854.

— — *Desh.* An. sans Vert. du Bassin de Par., t. 11, p. 102, 1860.

Spec. Char. *O. testá orbiculatá, utrinque gibbosá; in medio plus minusve subangulatá, vel semicylindraccá; valvâ inferiore convexá, extus irregulariter lamellosá; valvâ superiore striatá; striis tenuibus, divaricatis, instructá; marginibus supernè crenulatis.*

Shell suborbicular; lower valve convex, and irregularly laminated; upper valve ornamented with fine, longitudinal, and divaricating striæ; margin of the valve crenulated above on each side of the hinge.

Dimensions, 5 inches by 4.

Localities. Bracklesham (*Edwards*).

France, Valmondois et Senlis (*Deshayes*).

This species is not abundant, and it is confined, I believe, to Bracklesham. The peculiarity of this shell, whence I presume it received its name, is the elevation of the centre of the upper valve. This arises from an adherence of the animal to some cylindrical body, by which a considerable indenture is given to the outside of the lower valve and an elevated ridge to the inside; this is communicated to the upper valve, in order to give room to the animal inhabitant, and thus an elevated, semi-cylindrical ridge is on the outside of the upper valve, corresponding with the body adhered to. Specimens sometimes occur which have been attached by the greater portion of the lower valve to a flat surface, and the upper valve in this case has no elevation, but its favorite habit was apparently to select a cylindrical stem for support. The upper valve is covered with fine striæ, and the interior has the margins crenulated near the hinge; but M. Deshayes figures a specimen (pl. 64, fig. 3) in which the crenulations have extended round the entire margin of the upper valve. This is not so in the British specimens which have come under my inspection. The ligamental area is large and broad.

8. OSTREA ELEGANS? *Deshayes*.

OSTREA ELEGANS. *Desh.* Coq. Foss. des Env. de Par., p. 361, pl. 50, figs. 7—9.

— — *J. Sowerby*, in Dixon's Geol. of Sussex, p. 174, 1850.

— — *J. Morris*. Catal. Brit. Foss., p. 174, 1854.

“This is intermediate in several respects between *O. radiosa* and *O. flabellula*, but has more plaits than the latter. I much doubt the propriety of separating it as a species.”—*J. Sowerby*.

I am inclined to think with Mr. Sowerby that the English fossil called *elegans* is only a variety. There is not any fossil in Mr. Edwards's collection that deserves to be called *elegans*, in specific contradistinction to *radiosa*, Sow., *flabellula*, or *cymbula*; and as the above name is given upon the authority of Mr. Edwards's specimens, it is introduced here without a figure, and with considerable doubt.

9. OSTREA FLABELLULA, *Lamarck*. Tab. III, fig. 4, *a—d*.

CHAMA PLICATA. *Solander*, in Brander, Foss. Hant., pl. viii, figs. 84, 85, 1766.

OSTREA FLABELLULA. *Lam.* Ann. du Mus., t. viii, p. 164, No. 16; and t. xiv, pl. 20, fig. 3, *a, b*, 1806.

OSTREA FLABELLULA.		<i>J. Sowerby</i> . Min. Conch., t. 253, 1819.
—	—	? <i>Basterot</i> . Coq. Foss. des Env. de Bord., p. 72, 1825.
—	—	<i>Deshayes</i> . Coq. Foss. des Env. de Par., p. 366, pl. 63, figs. 5—7, 1825.
—	—	<i>Goldfuss</i> . Petr. Germ., t. 11, p. 14, No. 33, pl. 76, fig. 6, <i>a—g</i> .
—	—	<i>Galeotti</i> . Mém. de l'Acad. de Brux., t. xii, pl. iv, fig. 6, <i>a, b</i> , 1837.
—	—	<i>Nyst</i> . Coq. Foss. Belg., p. 323, pl. 29, fig. 3, <i>a, a', b, b'</i> , 1843.
—	—	<i>Bronn</i> . Leth. Geogn., B. iii, p. 352, t. 39, fig. 15, <i>a—c</i> , 1848.
—	—	<i>J. Sowerby</i> , in Dixon's Geol. of Sussex, p. 95, pl. 4, fig. 5, 1850.
—	—	<i>Deshayes</i> . An. sans Vert. du Bassin de Par., p. 120, 1860.
—	DEFORMIS.	<i>Id.</i> Coq. Foss. des Env. de Par., t. i, p. 346, pl. 55, figs 7, 8.
—	SUBPLICATA.	<i>Id.</i> - - - - - p. 345, pl. 48, fig. 3.
—	BIFRONS.	<i>Id.</i> 2d edit. Lam., t. vii, p. 242, 1836.

Spec. Char. *O. testá cuneatá vel ovato-orbiculari; valvâ inferiore plicatâ, plicis radiantibus, rugosis, arcuatis, hinc indè furcatis; valvâ superiore planâ concentricè striatâ; intùs lævi vel obsoletè ad marginem denticulatâ.*

Shell wedge-shaped or ovately orbicular; lower valve plicated or ribbed; ribs rugose, radiating, and bifurcating in the older shell; upper valve flat, concentrically striated, with the inner margin finely or obsoletely denticulated.

Longest diameter, $1\frac{1}{2}$ inch.

Localities. Barton, Bracklesham, Bramshaw, Clarendon, Southampton, Stubbington, Whitecliffe Bay (*Edwards*), Bagshot, Clewett's Green, Headley on the Hill, Orpington, Sundridge, (*Prestwich*).

France, Grignon, Parnes, Courtagnon (*Desh.*), Bayonne (*D'Archiac*).

Belg., Le sables d'Uccle, de St. Gilles, de Foret, de Lacken, &c. (*Nyst*).

The two specimens from Barton, figured in Brander, Nos. 84 and 85, pl. vii, are considered by some authors to belong to two distinct species, viz., *O. flabellula* and *O. cymbula*.

In Mr. Edwards's cabinet is a group of these shells from Barton, adhering to each other, one of which possesses the ovate form of *cymbula*, while another has the cuneate or typical form of *Ch. plicata*, Br., 85; and I cannot imagine that they were otherwise than the offspring of the same parent, and I believe that the two shells figured in Brander belong to the same species. Groups of these varying forms are not uncommon also at Bracklesham.

The English specimens vary much in outline, some being cuneiform or triangular, while others are oval: this difference does not appear to be the result of impediment to the natural growth, and it is principally by the outward form that the specific distinction has been made, the angular one constituting *flabellula*, and the ovate one *cymbula*. Sometimes this species adheres broadly and firmly to some foreign body, and a large space is left upon the shell denoting the place of adherence, while in other specimens there is scarcely the

slightest mark of attachment. When it adheres to a cylindrical stem the shell is much elevated, and the form of the body is communicated to the upper valve, giving it a ridge, like that found in specimens of *O. dorsata*. In thick individuals the ligamental area of the lower valve is much elongated, while in thinner shells this space is very short. The upper valve is plain, never radiated, but has merely concentric lines of growth: sometimes it is slightly convex, while at others it is irregularly concave or with a depression in the centre of the shell; it is also sometimes strongly denticulated on each side of the hinge-area; in one specimen I counted as many as twenty, in others there are scarcely any. The lower valve also possesses these denticulations more or less, but their number is no guide in specific determination.

A fossil from the Nummulitic Formation of Cutch has been figured and described under this name in the 'Geol. Tr.' vol. v, pl. xxv, fig. 18, specimens of which are in the Museum of the Geological Society.

O. angulata, fig. 17, on the same plate, comes even nearer in form to *flabellula*; it is possible that they may both be the same as the British species, which was very variable, and had an extensive range. The specimen, Tab. VIII, fig. 5, *a, b*, is from Clarendon, and although it presents differences, I have regarded it as a dwarf variety (*modicella*), from its general resemblance to the typical form. In this shell there is very great inequality in the two valves.

A specimen of the lower valve of this species has been met with in the Red Crag, at Sutton, and in good condition. It is therefore probable that the bed which originally contained it, and out of which it was derived, was not very remote from where it was found.

This species is so generally known as a British fossil under the above Lamarckian name, that I do not feel disposed to change it, although it ought to be called by Solander's name, *plicata*.

10. OSTREA GIGANTEA, *J. Sowerby*. Pl. II.

OSTREA GIGANTEA. *J. Sow.* Min. Conch., t. 64, 1814.

- — ? *Rousseau*. Voy. dans la Russie Méridionale, vol. ii, pl. 4, fig. 1.
- — ? *Leymerie*. Mém. de la Soc. Géol. de Fr., 2d ser., vol. i, pl. 17, fig. 2.
- — ? *Baily*. Foss. Inv., from the Crim. Quart. Jour. Geol. Soc., vol. xiv, p. 143, 1858.
- LATISSIMA. *Desh.* Coq. Foss. des Env. de Par., t. i, p. 336, pl. 52 and 53.
- — *Galeotti*. Mém. Cour. par l'Acad. de Brux., t. xii, p. 151, pl. 4, fig. 18, 1837.
- — ? *De Verneuil* and *Desh.* Mém. sur la Crimée, Mém. de la Soc. Géol. de Fr., t. iii, pt. 1, p. 19, pl. 4, figs. 1—3, 1838.
- PYRENAICA? *D'Orbigny*. Prod. de Palæont., t. ii, p. 317, No. 548, 1850.
- GIGANTICA. *Solander*, in Brand., Foss. Hanton., p. 36, No. 88, pl. 8, fig. 88, 1776.
- — *Nyst*. Coq. Foss. de Belg., p. 314, pl. 27, fig. 1 *b*; pl. 28, fig. 1 *a*, 1843.
- — *Desh.* An. sans Vert. du Bassin de Par., t. i, p. 108, 1860.

Spec. Char. *O. testá magná, crassissimá, ovato-circulari, inæquivalvi, irregulariter lamellosá; valvá inferiore gibbosá, convexá; valvá superiore planá, impressione musculari sublunari, profundá; umbonibus brevibus; cardine plano-triangulari, striato, foveolá profundá; marginibus supernè rugoso-plicatis.*

Shell large and thick, ovately circular, inequivalved, irregularly lamellated; inferior valve gibbous and convex; upper valve flat; muscle-mark gibbosely lunate; beaks short, hinge area flattened and triangular, deeply marked with lines of growth; rugosely plicated on each side of the hinge.

Diameter, 6 inches.

Localities. Bognor, Barton (*Edwards*), Cuffell near Basingstoke (*Prestwich*).

Belgium, Kleyen Spauwen; Piétrebais, près de Chapelle St. Laurent (*Nystr*); Middle Limburg (*Lyell*).

France, Chaumont, Valmondois (*Deshayes*).

M. Bronn (*Leth. Geogn.*, b. 11, p. 355) has considered the fossil found in the Crimea, called *gigantea* by MM. De Verneuil and Deshayes, as a distinct species, to which he has given the name of *O. Pyrenaica*; and he is not alone in this opinion. If the figure by M. Deshayes represents its constant character, the muscle-mark appears to be not only of a different form, but to be situated nearer to the hinge than in our specimens. Form, in this genus, is of itself a character by no means to be depended upon, as the shell is frequently distorted.

Fig. 6, Tab. VIII, appears to me to possess the characters required for a place in this species. The principal difference is in the shape; the lengthened beak, and elevated muscle-mark, are consequent upon its peculiar form; but the cicatrice is of a different colour from the shell, as is usual in *gigantea*. The rugosities, or denticulations, at the shoulders which distinguish this species are not very evident, although there are traces of them, and they are perhaps destroyed.

Mr. Sowerby, in Dixon's 'Geology of Sussex,' pp. 95 and 173, introduces an oyster under the specific name *elephantopus*; and, after giving a full description, but no figure, says, "This differs from *gigantea* in the form of the hinge-pit, which is considerably elevated in that species, and in the depth of the hollow valve. It shows the same cellular tissue as *O. cariosa* of the Bognor Rock, which may possibly be the young of the same species, although such large specimens have not been found at that place."

The specimen to which the name *elephantopus* is attached in the late Mr. Dixon's collection in the British Museum is an upper or right valve of great solidity; but it does not appear to me to offer any character that will separate it from *gigantea*, to which I believe it belongs. The peculiarity of the hinge in extending inwards is the result of the excessive thickening of the shell, by the successive layers of calcareous matter over the entire surface of the interior. Similar specimens are in the cabinets of Mr. Edwards and Dr. Bowerbank, and I am unable to detect any other difference than that which has been produced by age. These shells possess the same peculiar structure, as is so strikingly displayed in some

specimens of the upper valve of *gigantea*, from Barton. This structure is not, in general, so evident in the lower or left valve, where the exterior generally appears foliaceous; but the carious structure may be observed, where there is a fracture.* The Barton specimens appear to have adhered broadly. Dr. Bowerbank's specimen, from Bracklesham, exhibits scarcely any mark of attachment. One of my specimens, from Barton, had been fixed to a cylindrical body, which has imparted to the upper valve a semi-cylindrical elevation like that characteristic of *dorsata*, which it much resembles; and the outer surface, where it is preserved, is covered with fine radiating striæ, which are occasionally in ridges, like those represented upon *O. oblonga*, Brander, Pl. VII, fig. 83. I suspect that this last specimen was only an imperfect individual of the present species. There is a great tendency to thickening of the shell in those from Bracklesham. One aged specimen in Dr. Bowerbank's museum has the following dimensions:—diameter, 5 inches by 4, *thickness of shell* in this lower valve, two inches and four tenths. *O. callifera* (from Cutch), J. Sowerby (Tran. Geol. Soc., vol. v, pl. ii, second series, pl. xxv, fig. xvi), is a shell in that state, probably belonging to this species.

Ostrea cariosa is given by Professor Morris, in his catalogue, as a British fossil; and it is also introduced by Mr. J. D. C. Sowerby, in Dixon's 'Geology of Sussex,' pp. 117, 226; I have not seen a specimen on which this specific isolation might be founded. May it not be the young state of *gigantea*? as suggested by Mr. Sowerby.

11. OSTREA GRYPHOVICINA, S. Wood. Tab. VII, fig. 6, a, b.

Spec. Char. *O. testá crassá, ovatá; valvâ inferiore tumidâ, profundâ, obsoletè lamellatâ; valvâ superiore planiusculâ, nudâ; cardine magno, trigono, fossulâ ligamenti angustissimâ, excavatâ; marginibus integris; impressione musculari subrotundâ, parvâ.*

Shell thick, ovate; lower valve tumid and deep, with almost obliterated lamellæ; upper valve flattened and nearly smooth; hinge area broad, with a long, narrow, and deep ligamental furrow; margins free from crenulations; muscular impression round and small.

Height, $2\frac{1}{2}$ inches.

Localities. Sheppey (*Bowerbank*), Hampstead (*Wetherell*).

The peculiarly deep, contracted, and elongated ligamental pit in these shells differs from any other that I have seen, and gives reason to believe that they belong to a distinct species; the shape of the muscle-mark appears also to be different from any other. In the specimen belonging to Mr. Wetherell there is an obtuse lateral lobe separated by a shallow sinus

* On requesting Dr. Carpenter to give me his opinion upon this peculiar appearance, he says:—"I think it likely that the structure you allude to is one which I have seen in various large oysters, both recent and fossil, and which was first noticed, I believe, by Dr. J. E. Gray, namely, a cancellated tissue filling up the space that would otherwise be left empty between separated lamellæ."

on the siphonal region, like the character generally given for *Gryphæa*, and on the tablet of Dr. Bowerbank's specimen was written the name of *Gryphæa*; I cannot see anything to distinguish it generically from *Ostrea*, except the very small place of attachment, which of itself is insufficient.

12. *OSTREA INFLATA*? *Deshayes*. Tab. VII, fig. 4.

OSTREA INFLATA. *Desh.* Coq. Foss. de Par., t. i, p. 359, pl. 58, figs. 4, 5, and pl. 59, figs. 1, 2, 1825.

— — *J. Sow.*, in Dixon's Geol. of Suss., p. 95, t. iv, fig. 7, 1850.

— — *Morris*, Catal. Brit. Foss., p. 174, 1854.

Spec. Char. "*O. testá ovato-deformi, profundá, gibbosá; valvá inferiore rariplicatá; umbone angusto; fossulá ligamenti angustá, marginibus supernè crenatis.*"

Shell deformedly ovate, deep, inflated (?), lower valve with few radiating ridges, umbones sharp, ligamental area narrow, superior margins crenulated.

Longest Diameter, $1\frac{1}{2}$ inch.

Localities. Bracklesham (*Edwards*).

France, Valmondois (*Deshayes*).

This is not at all a satisfactory species. I have only two or three specimens from Mr. Edwards's cabinet that appear to correspond with the above diagnosis of M. Deshayes. They are left valves, and have adhered, near the margin of the shell, to some cylindrical body; they are by no means "inflated," but shallow. The shell figured by M. Nyst, under this name, appears to be very different from the British specimens.

13. *OSTREA LONGIROSTRIS*, *Lamarck*. Tab. VI, fig. 4.

OSTREA LONGIROSTRIS. *Lam.* An. du Mus., t. 14, pl. 21, fig. 9.

— — *Desh.* Coq. Foss. de Par., t. i, p. 351, pl. 54, figs. 7, 8; pl. 60, figs. 1—3; pl. 61, figs. 8, 9; pl. 62, figs. 4, 5; and pl. 63, fig. 1.

— — *J. Sow.*, in Dixon's Geol. of Sussex, p. 174, t. iv, fig. 4, 1850.

— — *Morris*, Catal. Brit. Foss., p. 175, 1854.

— — *Desh.* Hist. des An. sans Vert. du Bass. de Par., t. ii, p. 110, 1860.

Spec. Char. *O. testá diversiformi, ovato-rotundatá, vel elongato-irregulari; foliaceá, rugosá, incrassatá; striis lamellosis transversis instructá; valvá inferiore profundá; umbone longissimo, canaliculato, irregulariter contorto, acuto, trigono, tenuè-striato vel sulcato; fossulá utroque latere marginatá.*

Shell variable, ovately rounded, or elongately irregular, foliaceous, rough, and very thick; inferior valve deep, with a very elongated ligamental area strongly marked with transverse striæ or lines of growth.

Dimensions, 4 inches by 2.

Localities. Hempstead (*Edwards*), Bracklesham (*Dixon*).

France, Montmartre, Sceaux, Longjumeau (*Deshayes*).

There are two or three species in this genus which have an extended ligamental area, and are equally deserving of the present or a similar appellation.* The fossil oyster from Lisbon has the hinge area as long as that of the Eocene species, and it has also been called *longirostris*, but the shape of the shell is very different. The recent American oyster *O. Virginica* (*O. crassa*, 'Chemn.,' vol. viii, p. 40, t. 74, f. 678), has a similar character, but is, I think, distinct.

The present species does not appear to have been abundant in the British Eocene Seas, and I have not seen the upper valve; M. Deshayes speaks of the French shell as by no means rare, and he gives four distinct varieties of his species. Philippi ('En. Moll. Sic.,' vol. ii, p. 64) introduces *O. longirostris* as a fossil from Syracuse, but he does not give a figure; he quotes Goldfuss, as well as Deshayes.

14. *OSTREA MARGINIDENTATA*, *S. Wood*. Tab. V, fig. 2, *a—d*.

OSTREA RADIOSA. *J. Sow.*, in *Dixon's Geol. of Sussex*, p. 174, 1850.

— — — *Morris*. *Catal. Brit. Foss.*, p. 175, 1854.

Spec. Char. *O. testá ovatá vel orbiculatá, crassá; valvâ inferiore plicatá, plicis squamosis, radiantibus; valvâ superiore planá; marginibus valdè crenulatis vel denticulatis; impressione musculari magnâ.*

Shell ovate or orbicular, thick, and strong; lower valve plicated, with radiating and rough ridges or ribs; upper valve flat and plain, margin crenulated, muscular impression large and slightly curved or reniform.

Diameter, $3\frac{1}{2}$ inches.

Locality. Bracklesham (*Edwards*.)

This is by no means rare. Among Mr. Edwards' specimens there is great variation. Fig. 2, *d*, resembles the form and most of the characters of *O. extensa*, as given by M. Deshayes. Many specimens from Bracklesham have adhered by a large surface, extending over nearly the whole valve; in these cases the interior is shallow, and the shell is more orbicular; when the adherence is by a small portion of the surface or by the beak only, the valves are then more elevated and deeper. I have given a view of the interior of both valves, to show the difference in form of the adductor muscle-mark. In the specimen, fig. 2, *a*, the animal has extended the shell into a sort of shoulder; and the adductor muscle has followed the course taken by the mantle; from this distortion the muscle-mark is much altered.

* I have retained the name of *longirostris* for this species, as it is presumed to be identical with the Paris Basin shell, which was the one originally so called.

This fossil has been hitherto assigned to *O. radiosa*, Desh., and I feel reluctant to alter the name; but the large denticulations which are found invariably, in a greater or less degree, on the inner margin of the upper valve in well-preserved specimens, appear to offer a good specific character in contradistinction to the French shell of that name.

15. *OSTREA MULTICOSTATA?* Deshayes. Tab. VI, fig. 3, *a*, *b*.

OSTREA MULTICOSTATA. Desh. Coq. Foss. des Env. de Par., p. 363, pl. 57, fig. 3—6.

— — Bronn. Leth. Geogn., b. iii, p. 352, t. 36², fig. 6, *a*, *c*.

— — ? D'Archiac. Anim. Foss. numm. de l'Inde, p. 273, pl. 24, 1854.

Spec. Char. *O. testá ovato-elongatá, subrectá, supernè acutá; valvâ inferiore costatâ, costis divergentibus; valvâ superiore planulatâ, lamellis tenuibus, concentricis, ornatâ; impressione musculari obliquâ.*

Shell ovately elongate, somewhat straight, with an acute umbo; lower valve covered with diverging ribs which bifurcate on the outer or older portion of the shell; upper valve flat, with small or fine concentric laminae or lines of growth; muscular impression oblique.

Height, 3 inches.

Locality. Bracklesham (*Edwards*).

France, Rethuil (*Desh.*).

A specimen in Mr. Edwards' collection corresponds with the figure and description by M. Deshayes above referred to, and I have therefore regarded it as an identity, although it is possible it may only be an enlarged growth of one of the Bracklesham varieties of *flabellula*. This is said to be abundant in France, where I presume there are better means of determining the species. The umbo in our shell is sharp and pointed, and the place of attachment is very small. The upper valve is plain, or without the least appearance of radiating striæ. The muscle-mark is of a somewhat transversely ovate form, *excentric*, and appears rather smaller, comparatively, than the one represented by M. Deshayes; the ribs in our shell are smoother or less scaly; these trifling differences would probably disappear in a large series.

16. *OSTREA PICTA*, *J. Sowerby*. Tab. VII, fig. 2.

OSTREA PICTA. *J. Sow.*, in Dixon's Geol. of Suss., pp. 95, 173, t. iv, fig. 1, 1850.

— — *Morris*. Catal. Brit. Foss., p. 175, 1854.

Spec. Char. *O. testâ crassâ, orbiculari, intùs purpureo-nigricante, lamellis vix distinctis; valvâ inferiore profundâ, valvâ superiore planatâ; areâ cardinali latâ; impressione musculari magnâ, suborbiculari.*

Shell thick, orbicular, uneven, not imbricated; lower valve deep, upper valve nearly flat; hinge area broad and flat, muscular impression large and orbicular; both valves coloured within.

Diameter, $3\frac{1}{2}$ inches.

Locality. Bracklesham (*Dixon*).

“Colour is so rare an occurrence among oysters, and especially among fossils, that we are glad to accept it for a specific mark. The present shell belongs to a section of the genus which contains species whose surfaces are not imbricated, but covered by a continuous plate of a fibrous structure; in this the structure is, however, obscure; in *O. tabulata* and *O. dorsata*, &c., it is very easily detected. Old shells seem to be imbricated because the edges of the laminae are worn away. The surface of the young shell, well shown in an individual which has been attached to a large *Nautilus*, is nearly smooth, but irregularly marked with distant, short, interrupted striae; the hinge area projects into the cavity of the shell.”—*Sowerby*.

This species is rare, and colour appears to be its most distinguishing character. The upper valve exhibits some depressed, broad, irregular, and rather obscure radiations, separated by a small depressed line and coloured rays; the lower valve shows a broad mark of attachment; and the shell is somewhat compact, with fine lines of growth and small or incipient lamellae, but it is less laminated than *gigantea*, which it otherwise much resembles; the muscle-mark is transversely rounded, and of the form usually assumed in the orbicular oysters.

17. *OSTREA PRONA*, *S. Wood*. Tab. III, fig. 3, *a*, *b*.

Spec. Char. *O. testá crassá, obliquá, cuneatá; valvá inferiore tumidá, inflatá, profundè plicatá, plicis radiantibus hinc indè furcatis, elevatis, angulatis; valvá superiore planatá; cardine introrsum recurvo.*

Shell thick, strong, oblique, and wedge-shaped; lower valve tumid, inflated, and deeply plicated; folds radiating, elevated, angulated, and bifurcated; upper valve flat, plain; umbo inflexed.

Diameter, $2\frac{3}{4}$ inches.

Localities. Brockenhurst, Lyndhurst (*Edwards*).

This shell is by no means rare in Mr. Edwards' cabinet. The young of this species strongly resembles *O. flabellula*, and like other species in several genera, the immature shell can scarcely be distinguished from some proximate species of less magnitude. I think, however, there is sufficient difference in the full-grown individual to justify its specific separation. The ribs or folds in this species are perfectly angular in well-preserved specimens, while in *flabellula* they are obtuse or rounded; this difference is its principal distinction.

An oyster from Kleyn Spauwen was obligingly sent to me some years ago by the Comte du Chastel, but without a name. The specimen is, I believe, identical with the Brockenhurst shell; it resembles it even in colour.

18. *OSTREA PULCHRA*, *J. Sowerby*. Tab. I.

OSTREA PULCHRA. *J. Sow.* Min. Conch., t. 279.

— — *Morris.* Catal. Brit. Foss., p. 175, 1854.

Spec. Char. *O. testá magná, orbiculato-ovatá, crassá, depressá; valvá inferiore convexá, lamellatá, in juventute plicatá vel costatá; valvá superiore planatá; cardine brevissimá; impressione musculari ovato.*

Shell large, roundly ovate, thick, depressed; lower valve convex, lamellated, and plicated or costated in the young state; upper valve plain and flat, hinge very short; muscular impression ovate.

Diameter, 7 inches.

Localities. Reading, Clarendon (*Edwards*).

Small var. Bromley, Tyler's Hill near Chesham, Old Basing (*Prestwich*). |

This species differs from *O. Bellovacina* in being more numerously rayed or costated in the lower valve of the young shell; these ridges become nearly obsolete as it advances in age, and the upper valve is naked, or free from radiating ridges. The Reading specimens are generally orbicular, those from Clarendon have the greatest diameter from the umbo to the ventral margin.

In the Reading specimens many have the two valves united, and the ligament preserved; the small shell figured Tab. IV, fig. 2, *a, b*, is the representation of what I imagine to be the young state of the upper or right valve of this species from Clarendon; the umbo is much recurved or inflected after the manner of *Gryphæa* or *Exogyra*, and on each side of the hinge the margin is crenulated or denticulated; this character may be seen in some of the large and full-grown specimens of this species from Clarendon. Mr. Edwards' specimen of this species from Reading measures seven inches and a half in the longest diameter, and I think the animal inhabitant must have attained to the dimensions of at least six inches, with a depth of rather more than one inch. The shell figured in 'Min. Conch.' from Bromley, above referred to, represents what I believe to be a small variety of this species, and the same kind is also found at Sunning Hill.

19. *OSTREA TABULATA*, *J. Sowerby*. Tab. IV, fig. 1, *a*, *b*.

OSTREA TABULATA. *J. Sow.*, in Dixon's Foss. of Suss., pp. 117, 226, 1850.

— — *Morris*, Catal. Brit. Foss., p. 175, 1854.

Spec. Char. *Testá orbiculatá, depressá; lævigatá; valvâ inferiore imbricatâ obscuré radiatâ; valvâ superiore planâ, nitidâ, politâ; umbonibus parvis.*

"Shell orbicular, depressed, smooth; upper valve slightly concave, even, its plates few, with distant, scarcely raised edges; lower valve obscurely marked by radiating undulations, its plates few, in groups, with remote, deeply imbricating edges; beaks small, pointed; muscular impression ovate, curved, of a moderate size."—*Sowerby*.

Diameter, 7 inches,

Locality. Bognor.

This is an abundant shell at Bognor, to which locality it appears to be restricted.

Mr. Sowerby remarks "that it was evidently a rapid growing shell; its nearly smooth external laminae extend far between each period of growth, and show their fibrous structure distinctly, especially upon the surface." The specimens generally have adhered only in the young state by a very small portion of the surface, and are solitary. I have rarely seen them in groups. A specimen in Mr. Wetherell's cabinet shows the muscle-mark to be rather elongate, and more curved than is the rounded form of this mark in *gigantea*. The lower valve in the young state is obscurely rayed, and the upper is generally glossy, and the shell is flatter or more compressed than that of *gigantea*.

20. *OSTREA TENERA*, *J. Sowerby*. Tab. VI, fig. 1, *a*, *b*.

OSTREA TENER. *J. Sow.* Min. Conch., t. 252, figs. 2, 3, 1819.

— *TENERA*. *Id.*, in Dixon's Foss. of Suss., p. 174, t. iv, figs. 2, 3, 1850.

— — *D'Orbigny*. Prod. de Palæont., t. ii, p. 307, No. 199, 1850.

— — *Morris*. Catal. Brit. Foss., p. 175, 1857.

Spec. Char. *Testâ elongatâ, attenuatâ, angustâ, depressâ valvâ inferiore sub-planâ, transversim lamellosâ, valvâ superiore striatâ vel inornatâ; umbonibus longis attenuatis; fossulâ ligamenti angustâ.*

Shell elongate, attenuated, depressed; lower valve very slightly convex and transversely lamellated; upper valve flat, striated, or plain; umbones attenuated, ligamental; area long and pointed.

Height, $4\frac{1}{2}$ inches.

Localities. Woolwich, Sundridge Park, New Cross, smooth and thick var. (*Prestwich*).
Bracklesham, thin and striated var. (*Edwards*).

"The Woolwich type of this species is generally smooth ; but I have reason to think that the fibrous striated coat is more easily decomposed than the other laminæ of the shell, and has been therefore generally destroyed. Such appears to have been the case often with the Bracklesham individuals ; however, some of the latter, having the fibrous coat, are almost free from striæ, and others want them over more or less of the surface, which has induced me to consider the striated ones as only varieties of the others." (*Sowerby in Dixon.*)

In support of the above remark, I may observe, that some of Mr. Edwards' specimens from Bracklesham show the upper valve to be quite free from ornament ; others are fully covered over with numerous fine striæ ; and one specimen unites these two varieties, the younger half of the upper valve being covered with striæ, and the lower or older portion being quite plain ; both parts are apparently without decortication.

O. angustata, Desh., in many characters strongly resembles this species ; but it appears rather more attenuated in the hinge than any of our British specimens, although such a difference as this may be accidental. In the representation of the French shell are a few depressed and irregular ribs, and the shell is free from striæ, but there are vestiges of radiating plicæ or obsolete ribs in our species.

The full-grown specimens may be said to have proportions generally of about three to one, but a full-grown specimen in Mr. Edwards' cabinet is not more than two to one and a half. In the young state the shell is often nearly orbicular, becoming elevated as it increases in size. One of our specimens has a very pointed umbo, and this is somewhat recurved.

21. *OSTREA VECTIENSIS*, *Forbes MSS.* Tab. VII, fig. 5, *a—c.*

OSTREA VECTENSIS. *Morris.* Mem. Geol. Surv. pp. 68, 150, t. 3, fig. 9, 9 *a*, 9 *b*, 1856.

— — — *Id.* Cat. Brit. Foss., p. 175, 1854.

Spec. Char. "*Testá ovato-trigoná, oblongá, attenuatá, sub-angustá ; arcá cardinali fossulá triangulari, latá, recurvá exarátá ; umbonibus obtusis ; valvá superiore lineis incrementi numerosis ornatá ; valvá majore crassá, extùs rugosá.*"

An oblong and rather narrow shell, with the larger valve somewhat thick and externally rugose ; the upper valve flat, thin, recurved at the umbo, and marked by numerous concentric lines of growth ; ligamental area broad and triangular." (*Morris.*)

Longest diameter, $1\frac{1}{2}$ inch.

Locality. "Sandy beds of the Bembridge series." (*Morris.*)

This species does not appear to be rare ; several specimens are in the Museum in Jermyn-street.

The right valve has occasionally crenulations in the margin near the hinge ; but as this valve is often quite free from them ; the form of the shell is also exceedingly

variable. Fig. 5, *c*, resembles *O. Sparnacensis*, Desh. (pl. 64, figs. 5—8.) The hinge (which is peculiar) is very similar, although, if that figure be correct, the muscle-mark is not so elongated as in our species. Fig. 5, *b*, is, I imagine, the lower valve of a specimen belonging to this species, and its recurved umbo gives it the appearance of a *Gryphæa*. None of the specimens in Jermyn-street possessed, that I could see, the radiations spoken of by M. Deshayes as distinguishing *O. gryphina*; and there is no diagnosis or any remark by the late Professor E. Forbes, on whose authority that species is introduced (Mem. Geol. Survey., 1856, p. 88.) I am therefore unable to consider *Gryphina* as a British species.

22. *OSTREA VELATA*, *S. Wood*. Tab. VII, fig. 1, *a*, *b*.

Spec. Char. Testá ovato-trigoná, sub-obliquá; areá cardinali latá, incurvá; valvá inferiore lamellatá; lamellis subregularibus, fimbriosis; valvá superiore planulatá, striatá; striis magnis, undulatis.

Shell ovately trigonal, somewhat oblique; cardinal area rather broad, incurved; inferior valve lamellated, the lamellæ in general regular, fimbriated, or projecting; upper valve flattened and striated, striæ large and undulating.

Diameter, 2 inches.

Localities. Colwell Bay (*Edwards*), Whitecliffe Bay (*Prestwich*).

This is rather a pretty looking shell, and does not appear at all rare. Its great peculiarity consists in being striated upon the upper valve. The striation in our specimens exists only in the outer coating of the upper valve; this coating is sometimes entirely removed, and is seldom seen except in patches. I thought at one time it might have belonged to *cochlearia*, and that the French specimens had lost this outer cuticle; but there are no "obscure plications" in the lower valve, which the French fossil is said to possess, but it is regularly lamellated or fimbriated. I have, therefore, with reluctance felt compelled to give it a new name. The upper valve of this species, much distorted, I found, many years ago, in the small patch of marine shells which intervenes between the fresh-water deposits on the Hampshire Coast, at Hordwell. *O. cochlear*. Poli, is a recent species, and is quite distinct. *O. cochlear*., Nyst (p. 330, pl. 32, fig. 2), which he gives as a fossil from Hoesselt and Lethen, in the Limburg, appears from figure and description, to be different from any oyster that I have seen from the older Tertiaries of England. *Cochlearia* is a name attached to several specimens of *Ostrea* in the Museum in Jermyn-street; but these specimens appear to me to belong either to *Vectensis* or to this species. In the second part of 'Coq. Foss. des Env. de Paris,' t. 2, p. 114, the author considers his former species of *O. cochlearia* as a variety of *O. cyathula*.

23. *OSTREA ZONULATA*, *S. Wood*. Tab. X, fig. 4, *a—c*.

Spec. Char. *O. testá elongato-ovatá, tenui, fragili, valvâ sinistrâ convexâ, profundâ, imbricatâ; imbricibus tenuibus, distantibus; valvâ dextrâ planâ, lamellatâ; cicatriculâ musculari minimâ, reniformi; areâ cardinali angustâ.*

Shell elongately ovate, thin, and fragile; left or lower valve convex, deep; upper valve flat and lamellated, lamellæ or fimbriations thin and distant; muscular impression small; cardinal area narrow.

Longest diameter, $1\frac{1}{2}$ inch.

Locality. Hill Head, near Stubbington. (*Fisher*.)

The above shell has been recently obtained by the Rev. Osmond Fisher, who has kindly permitted me to have it figured.

It somewhat resembles *O. velata* in the regularity of the imbrications, but it differs in having these imbrications fewer in number, and they are broader, more thin, and delicate; besides which, the upper valve in this species is quite free from the striæ which form so marked a feature in the upper valve of *O. velata*.

Fig. 4, Tab. VIII, represents a specimen of the upper valve of an oyster, from the cabinet of Mr. Edwards, and found at Bracklesham. This was figured previous to the discovery of the above species, and it was then considered so closely to resemble the French Eocene fossil, *O. lamellaris*, Desh. (Coq. foss. des Env. de Paris, pl. 54, figs. 3, 4), as to deserve a representation, from a possible identity; but in the subsequent work by the same author (An. sans Vert. du Bassin de Paris, t. xi, p. 106), that shell is referred to *O. multistriata*, in which species the upper valve is represented as finely and closely striated. Our shell is quite free from striæ of any kind, and it does not appear to have been decorated. I am now therefore inclined to refer it to the present species.

In the 'Quarterly Journ. of the Geol. Soc.,' 1854, p. 117, Mr. Prestwich speaks of an oyster as having been met with at Kyson (*O. Bellovacina?*); but the specimen cannot be found. Mr. J. C. Moore obtained an oyster in an estuary deposit in the New Forest. 'Journ. Geol. Soc.,' vol. v, p. 316, 1849. This specimen also we have not been fortunate enough to find.

VULSELLA. *Humphries*, 1797.TELLINA (sp.) *Rumph.*, 1705.PINNA (sp.) *Linn.* 1758.MYA (sp.) *Id.* -BAPHIA (sp.) *Gevers*, 1787.OSTREA (sp.) *Brug.*, 1789. *D'Orb.*, 1850.VULSELLA. *Lamk.*, 1799.DALACIA? *Gray*, 1825.RENIELLA. *Swains.*, 1840.

Gen. Char. Shell somewhat irregular, elongated, compressed, inequivalved, free; hinge with connexus external or ligamentous; umbones straight, remote, earless; one muscular impression in each valve, subcentral.

This is a genus containing but few species, either in the recent state or as fossil. Six recent species have been described, and these are confined to the Oriental seas.

Lamarck had placed this genus close to *Ostrea*, to which in many of its characters it bears a great resemblance; it is truly monomyarian, and the connexus is situated as in the oyster, between divergent beaks upon an inclined plane, opening the valves by contraction. Cuvier removed it from that position to one in proximity with *Malleus*; and some authors still consider it only as a section of, or sub-genus to, *Avicula*. Judging from the shell alone, in the absence of a knowledge of the animal, the differences are too conspicuous to be included in that genus, and it appears to me entitled to claim an isolation equal to many other generally admitted genera.

Shells bearing the above generic characters have been found in the Chalk.

1. VULSELLA DEPERDITA? *Lamarck*. Tab. IX, fig. 2, *a—c*.VULSELLA DEPERDITA. *Lam.* Hist. des An. sans Vert., t. vi, p. 222, No. 7.— — *DeFrance.* Dict. des Sc. Nat., art. *Vulsella*.— — *Desh.* Coq. Foss. des Env. de Par., p. 374, pl. 65, figs. 4—6.— — *Id.* An. sans Vert. du Bass. de Par., t. 2, p. 51, 1860.— — ? *Grateloup.* Cat. des An. Foss. des Env. de Bord., p. 59, 1838.— — *Morris.* Cat. of Brit. Foss., p. 182.OSTREA DEPERDITA. *D'Orb.* Prod. de Palæont., p. 394, 1850.

Spec. Char. Testâ ovato-oblongâ, angustâ, inæquivalvâ, sub-lingulatâ, sublævigatâ, supernè tumidiore, apice retusâ; fossulâ cardinali magnâ, obliquè incumbente, laterali, basi prominulâ; areâ cardinali sinuato; impressione musculari sub-laterali, elongato-ovatâ.

Shell ovately oblong, elevated, and somewhat tongue-shaped, depressed and inequivalved, tumid at the upper part, with very divergent umbones; shell subnacreous, irregularly smooth with conspicuous lines of growth and a sharp margin, base prominent and rather pointed; muscular impression elongated.

Longest diameter, $1\frac{1}{2}$ inch.

Localities. Barton (*Edwards*).

France—Grignon, Chaumont, Mouchy, le Châtel (*Desh.*), Blaye, (*Gratel*).

The hinge-area in the British fossil has apparently a larger ligamental depression, and a smaller sinus than is represented in the French shell; but these differences would probably vanish on a comparison with specimens of the shells themselves. The connexus is somewhat on one side of the hinge-area, as if counteracting the action of the adductor muscle which is on the other. The left valve extends the ventral margin beyond the edge of the right, making the shell inequivalve, like the oyster.

The above name has been published for an English fossil, and, as I have not the means of disproving the identity, I have permitted it to remain with a mark of doubt. The shell, like most of the oyster tribe, has a tendency to great variation, and the muscle-mark partakes of the varying form of the shell. Since the above was written, I find the following observation by M. Deshayes, in 'Hist. des An. sans. Vert du bassin de Paris,' p. 51:—"L'espèce est citée dans le bassin de Londres par M. Morris; mais à Barton elle est accompagnée d'une autre très-distincte, beaucoup plus rapprochée par ses caractères d'une espèce vivante de la Mer Rouge, et d'une autre fossile du terrain nummulitique de l'Inde que M. d'Archiac a fait connaître sous le nom de *Vulsella lignium*."

I have made every effort to see the specimens here referred to, but without success. I am not aware that the genus has been found in the London basin, or anywhere but at Barton; and all the specimens that I have seen may, in my opinion, be referred to one species, but whether that be the true *deperdita* I cannot say.

PECTEN. *Pliny, Aldrovandus, &c.*

OSTREA (sp.).	Linn.— <i>P. opercularis</i> ,	Sect. <i>a</i> .
HINNITES.	Sow. (not DeFr.).— <i>P. pusio</i> ,	„ <i>b</i> .
JANIRA.	Schum.— <i>P. maximus</i> ,	„ <i>c</i> .
NEITHEA.	Drouet.— <i>P. quinquecostatus</i> ,	„ <i>d</i> .
PLEURONECTIA.	Swains.— <i>P. pleuronectes</i> ,	„ <i>e</i> .

Gen. Char. Shell lenticular or sub-orbicular, sometimes ovate, sub-equilateral, generally inequivalve; ornamented with radiating striæ or more or less elevated ribs: beaks approximate and acute, with a projecting and unequal auricle on each side of the umbo; pedal region slightly sinuated, right valve generally the more convex; connexus bipartite, the ligamental portion narrow on the straight hinge-margin, cartilage placed in a central pit,

elongately triangular; impression of the adductor somewhat obscure, excentric; double pedal impression visible in right valve, obsolete in the left; impression of the mantle not well defined.

Animal, with the edges of the mantle disconnected all round except at one part, which serves to separate the inhalent from the excurrent canal; margins double, each bearing a row of tentacular filaments, and at the base a row of black eyelets (*ocelli*); foot small, sub-cylindrical or digitiform, grooved, and byssiferous in the young state.

This constitutes a well-marked group, although the species present considerable diversity of character in their exterior ornaments. The valves are generally covered with radiating ribs or striæ, and in the very inequivalved species, of which *P. maximus* is the type, the rays are large and elevated, while at the other extremity, such as *P. pleuronectes*, the valves are nearly smooth, though still preserving the outward form and other characteristics of the genus.

The foot of the animal is very small and incapable of being extruded, and probably the only use it makes of this organ is to spin a byssus, which is employed principally in the young state; in some species, the animal when more advanced in age is capable of considerable locomotion.¹ In Chemnitz 'Conch. Cab.,' vol. vii, p. 261, vig. xi, there is a woodcut which represents the *imaginary* animal of *Pecten* (*opercularis*?) with two distinct and separated siphons, prettily ornamented with setæ or fibrillæ projecting beyond the margin of the shell, and a large geniculated foot is protruding to some distance in an opposite direction.

There is always more or less difference in the magnitude of the two valves in the shells of this genus, but it is in those species which lie habitually on one side that the great inequality is most distinct; the convex or tumid valve, being buried in the sand or mud, is usually colourless or fainter in ornament than the upper or flat valve, which is always exposed to the light.

The genus has a very extensive vertical range, the British species having been obtained alive by Mr. M'Andrew from the shore to the depth of 150 fathoms, though the most frequented habitats of two edible species, *maximus* and *opercularis*, are upon banks that do not extend beyond the range of thirty fathoms. Its geographical range is very extensive.

¹ The stationary habit of this genus is generally by means of a byssus; there is one species *P. pusio* of British authors, which fixes itself by the outside of the shell, like the oyster, but, unlike that genus, it employs the right valve, or that in which is left a sinus for the byssus; sometimes the whole of this large valve is soldered to the rock. In this it is connected with *Hinnites* (Defr.), which, however, is very different in all other respects. I have not seen a fossil *Pecten* possessing such a habit.

1. PECTEN BELLICOSTATUS, *S. Wood*. Tab. VIII, fig. 11, *a, b*.

Spec. Char. *Testá crassá, æquivalvi, orbiculari vel lenticulari, æquilaterali, costatá; costis 20-24 sub-rotundis, striatis et imbricatis; interstitiis lineatis et imbricatis; auriculis magnis, inæqualibus.*

Shell thick and strong, equivalved, orbicular or lenticular, equilateral, costated; ribs 20 to 24 somewhat rounded, striated, and strongly imbricated; interspaces also with imbricated rays: auricles large and unequal, one costated, the other striated.

Diameter, $1\frac{3}{8}$ ths of an inch.

Locality.—Brockenhurst (*Edwards*).

Our shell is a handsome one and highly ornamented, and, judging from the number of specimens in Mr. Edwards' cabinet, it does not appear to have been scarce. In addition to the above formula, it may be further noticed, that the centre of the elevated rib is not only strongly and regularly imbricated, but the imbrices are long, overlapping, and slightly projecting; they are not reflexed, but lie over each other like ornamental tiling; there is a smaller ray on each side of the centre one, which is also imbricated, and the two lines or rays on the interspaces are likewise covered with small imbrications. The auricle on the pedal side of the right valve is a very large one, and ornamented with about half a dozen costæ, while the other is only striated with numerous rays; and the ears of the left valve are both striated; angle of divergence, 90°. The nearest approach to this species is *P. Thorenti*, D'Archiac, Tr. Geol. Soc. Fr., 2d sér., t. xi, pt. 1, p. 211, pl. 8, figs. 8, 8, *a, b*, which much resembles it in the ornament, but the auricle of that shell is so much smaller that I must presume the two to be different. The figure there taken was from a solitary specimen, and the auricle, if natural, does not appear to me to be perfect.

2. PECTEN CARINATUS, *J. Sowerby*. Tab. IX, fig. 5, *a, b*.

PECTEN CARINATUS. *J. Sowerby*. Min. Conch., t. 575, 1828.

— — *Prestwich*. Journ. Geol. Soc., 1847, p. 405.

— — *Morris*. Cat. Brit. Foss., p. 178, 1854.

Spec. Char. *P. testá orbiculari, lenticulari, æquivalvi, æquilaterali, costatá; costis (circa 20) subæqualibus, rotundatis, in medio carinatis; interstitiis lævibus; auriculis subæqualibus.*

Shell orbicular, lenticular, equivalved, equilateral, costated; ribs about 20, nearly equal, rounded, with a sharp keel along the centre of each; interspaces generally naked, or only marked with fine lines of growth; auricles nearly equal.

Diameter, 1 inch.

Locality.—Barton.

I have seen this from one locality only. The solitary line spoken of by Mr. Sowerby, in 'Min. Conch.,' as generally running down the centre of the interspaces, is a character not constant; in some it is not visible, while in others this space is occupied with several lines. The spaces between the ribs are not quite so wide as the ribs themselves, and these show fine curving and radiating striæ. The keel in some individuals is large and strong, giving an almost angular form to the rib; but in general this keel is merely a sharp line upon the otherwise rounded costæ, closely approaching *P. reconditus*. The auricle on the pedal side is slightly the larger of the two, and in the right valve this auricle is costated and sinuated beneath, with three or four denticulations upon the margin of the shell.

3. PECTEN CORNEUS, *J. Sowerby*. Tab. IX, fig. 7, *a—d*.

PECTEN CORNEUS. *J. Sow.* Min. Conch., t. 204, 1818.

— — *Id.* in Dixon's Geol. of Sussex, t. 4, fig. 6, 1850.

— — *Nyst.* Coq. Foss. Belg., p. 299, pl. 23, fig. 1 *a, b*, 1843.

— — *Morris.* Cat. Brit. Foss., p. 178, 1854.

Spec. Char. *P. testâ tenuissimâ, orbiculato-depressâ vel plano-lenticulatâ, æquilaterali, lævigatâ, vel obsoletè striatâ; striis irregularibus; umbonibus acutis; auriculis subæqualibus, rectangulis, supernè prominentibus, tenuissimè striolatis.*

Shell very thin, orbicular, depressed, or of a flattened lenticular form; smooth, or with fine, nearly obsolete striæ; beaks sharp; auricles nearly equal, rectangular; generally with fine radiating striæ.

Diameter, $2\frac{3}{4}$ inches.

Localities, Bracklesham, Bramshaw, Brook, Stubbington (*Edwards*), Cuffell (*Prestwich*); var. *corneolus*, Highgate (*Wetherell*).

Belg., Les sables de Lacken, Jette, Forêt, St. Gilles (*Nyst*).

This species is abundant at Bracklesham, but, on account of its extreme tenuity, is not very common in cabinets. Our shell, which is smooth to the naked eye, exhibits under a common hand-glass fine diverging striæ, most distinct near the margins of the shell, and in well-preserved specimens they are plainly visible all over; it is also rayed irregularly on the inside. The auricles are plain and smooth, except under a magnifier, when the same kind of fine radiating striæ may be seen as are upon the shell. There are at the base of the auricles, on the interior, two prominent diverging teeth, those in the right valve being higher and smaller than in the other, and the adductor muscle-mark is very conspicuous, generally of a darker colour; this is large and rounded, and in the right valve, which is the deeper or more convex one, it is higher in the shell or nearer to the hinge than in the left or flatter valve, where it is more in the centre, giving a more powerful action to that valve, and the mark of the mantle is visibly impressed upon the interior. The shell is nearly orbicular, but sometimes the diameter is greater longi-

tudinally, sometimes the reverse; the ears are slightly unequal, the pedal one being a trifle the larger. The shell diverges from the umbo at an angle of about 120° , and the divergence of the lines upon the fainter portion of the shell at about 80° .

The typical specimens of this species are from Selsey, Bracklesham, and Stubbington, where they attain to full proportions. There are also specimens found in the London clay at Hampstead, assigned to this species; these are seldom more than half the diameter of the Sussex shell, and may be considered as a variety, which I will call *corneolus*, Pl. IX, fig. 7, *d*. The difference in magnitude would not of itself be sufficient to entitle these shells to the position of a variety;¹ but there is a slight variation in the right auricle, which is rather more rounded, and in some of the specimens the proportions are different, giving them a more ovate form.²

4. PECTEN CONTUBERNALIS, *S. Wood*. Tab. IX, fig. 8.

Spec. Char. *P. testá tenui, subcorneá, orbiculato-depressá, æquilaterali, tenuissimè striatá, striis radiatis argutis; umbonibus acutis; auriculis subæqualibus, supernè rectangulis, costellatis.*

Shell thin, subcorneous, orbicularly depressed, equilateral, and very finely striated, striæ thin and radiating, beaks acute; auricles nearly equal, and prominently radiated or costated.

Diameter, $1\frac{1}{8}$ th inch.

Locality. Herne Bay (*Edwards*).

This shell appears to present differences sufficient to entitle it to an isolated position: the elevated radiations or costæ upon the auricles will distinguish it; and the whole surface is more strongly marked by the fine, divaricating, and curving striæ with which it is covered, and these extend over the auricles. I have seen but one specimen, which is in Mr. Edwards' cabinet, but this differs so materially that I think it cannot belong to the preceding species. The auricles are comparatively much larger than those of *corneus*: in that shell their length does not exceed $\frac{4}{10}$ ths of the diameter of the valves, while in this species they are $\frac{6}{10}$ ths; and although the young shells of *Pecten* have generally larger ears, comparatively, than when full grown, a great difference may be seen in specimens of the two species of corresponding size.

¹ Since writing the above, I have seen a specimen of this variety in Mr. Wetherell's cabinet, which measures $1\frac{3}{4}$ inch in diameter.

² At p. 72, t. 11, 'Anim. s. Vert. du Bassin de Par,' M. Deshayes has pointed out the confusion that exists among species with the above name, and enumerates not less than seven, but which he considers to be quite distinct. One of these seven (*P. corneus*, Melville, pl. 111, figs. 11, 12,) very strongly resembles the young state of our shell, corresponding with the Highgate variety (*corneolus*).

5. PECTEN DUPLICATUS, *J. Sowerby*. Tab. VIII, fig. 10, *a—c*; and Tab. X, fig. 3.PECTEN DUPLICATUS. *J. Sow.* Min. Conch., t. 575, 1828.— — — *Morris.* Cat. Brit. Foss., p. 174, 1854.

Spec. Char. *P. testá orbiculari, depressá, radiatá; valvá dextrá sublævigatá; alterá costellatá; costellis numerosis, imbricatis; auriculis subæqualibus.*

Shell orbicular, depressed, radiated; one valve nearly smooth or with obsolete costæ, the other with thin rounded ribs, 14 to 16, imbricated, increasing with age by the interposition of an additional rib; auricles nearly equal.

Diameter, $1\frac{1}{2}$ inch.

Localities. Highgate, Primrose Hill (*Wetherell*), *a, b, f*, Haverstock Hill, *c*, Muswell Hill (*Edwards*).

A strongly marked and ornamental species, and in the living condition probably a handsome shell. The specimens in cabinets are by no means abundant, and rarely in good condition. Mr. Sowerby, in 'Min. Conch.,' represents one of his valves as quite smooth. In all Mr. Edwards's specimens, the right valve has more or less depressed or obsolete costæ, and as many as thirty of these faint rays may be counted; and these are distinctly visible in the interior. The left valve is ornamented with about sixteen thin, rounded, and imbricated rays on the younger shell; these are doubled, and again doubled, as the shell increases in size, by the interposition of a rib; they are all closely and regularly imbricated, but not the interspaces.

6. PECTEN IDONEUS, *S. Wood*. Tab. VIII, fig. 9, *a, b*.

Spec. Char. *P. testá inæquivalvi? suborbiculari, subdepressá, æquilaterali, costatá, et concentricè squamulatá; costis 13-15 elevatis, magnis, subquadrupartitis; auriculis, æqualibus radiantibus.*

Shell inequivalve? suborbicular, somewhat depressed, equilateral, costated, and concentrically striated; ribs 13-15, elevated, large, and ridged; auricles equal and radiated.

Diameter, $1\frac{1}{4}$ inch.

Localities. Hill Head, Stubbington (*Fisher*), Brook near Lyndhurst (*Edwards*).

This is an ornamental shell, and appears quite distinct. It was first discovered by the Rev. Osmond Fisher, who has obtained about a dozen specimens from the first locality, and Mr. Edwards has very recently added three to his cabinet from the latter.

In well-preserved specimens, the ribs are ornamented with one elevated and two lateral ridges, dividing the surface of the rib into four portions; the interspaces are about as broad as the ribs themselves, in which a ray or two may occasionally be seen on the outer or older portion of the shell; the surface, when perfect, is ornamented with regularly concen-

tric striæ or small imbrications. The auricles are nearly equal, and they are ornamented with eight or ten moderately sized rays.

7. PECTEN PRESTWICHII, *Morris*. Tab. VIII, fig. 7, *a*, *b*.

PECTEN PRESTWICHII.	<i>Morris</i> .	Geol. Journ.,	vol. viii,	p. 266,	t. 16,	fig. 8 <i>a</i> ,	<i>b</i> ,	1852.
—	—	<i>Id.</i>	Cat. Brit. Foss.,	p. 178,	1854.			
—	—	<i>Desh.</i>	An. sans Vert. du	Bas. de Par.,	p. 75,	pl. 79,	figs. 4—6.	
—	BREVIAURITUS?	<i>Id.</i>	-	-	-	-	p. 74,	1—3.

Spec. Char. “*P. testá tenui, compressá, radiatim obsoletè costatá, costis subsquamosis, interstitiis obliquè irregulariter striatis; auriculis inæqualibus, radiatis.*”

“Shell thin, compressed; margin orbicular, with a rectangular beak; radiated with very slightly raised ribs, distinctly imbricated, the intervening furrows twice as large as the ribs; irregularly and obliquely striated; ears unequal, with three or four radiated costæ.”

Diameter, 1 inch.

Localities. Richborough Castle (*Prestwich*), Herne Bay (*Bowerbank*).

This species possesses about sixty small ribs or rays, very slightly elevated, and the surface is covered with diverging or divaricating and curved striæ; these are most conspicuous as they approach the pedi- and siphoni-lateral margins; the auricles are comparatively large, unequal in size, with a small sinus at the base of the right one; these auricles are covered with about five or six rays. The diverging striæ appear to cover our shell, passing over the riblets, as well as between them; and there appears to be a large muscle-mark under the pedal auricle. I have seen only two specimens.

The British fossil corresponds so closely with the older species, *P. breviauritus*, that, judging alone from figure and description, I am unable to detect any difference which can fairly be called specific; and unless there be greater distinction shown between specimens when compared, the name of our species will have to be changed. In the figure given in the ‘*Geol. Journ.*,’ above referred to, the artist has reversed the auricles.

8. PECTEN RECONDITUS, *Solander*. Tab. IX, fig. 3, *a—d*.

OSTREA RECONDITA.	<i>Solander</i> .	Brand. Foss. Hant.,	p. 42,	pl. 8,	fig. 107,	1766.
PECTEN RECONDITUS.	<i>Nyst.</i>	Coq. Foss. Belg.,	p. 302,	pl. 25,	fig. 2 <i>a</i> ,	<i>b</i> , 1843.
—	—	<i>J. Sow.</i>	in Dixon’s Geol. of	Suss.,	t. 3,	fig. 27, 1850. <i>non.</i> Sow. Min.
			Conch.,	t. 575,	figs. 5,	6.
—	—	<i>Lyell.</i>	Belg. Tert.,	loc. cit. ant.	p. 353,	1852.
—	—	<i>Morris.</i>	Cat. Brit. Foss.,	p. 179,	1854.	
—	PLEBEIUS.	<i>Tennant.</i>	Strat. List. Brit. Foss.,	p. 31,	1847.	

Spec. Char. *P. testá æquivalvi, orbiculari vel subovatá, costatá, costis 18-24 convexis, lævigatis; sulcis æqualibus, aliquando squamulosis; auriculis inæqualibus.*

Shell equivalve, orbicular, sometimes sub-ovate costated; ribs 18-24, convex and smooth; interspaces about equal in breadth to the ribs, and occasionally sub-squamulose or imbricated; auricles unequal.

Diameter, $1\frac{1}{4}$ inch.

Localities. Barton.

Belgium (*Nyst*).

The prevailing *Pecten* at Barton possesses the above characters, and it may be considered the representative of the genus in that deposit, as the *30-radiatus* is at Bracklesham; and although perhaps this is not quite so variable as the Bracklesham shell, I have found it exceedingly difficult to fix the species.

The generality of our specimens are nearly circular; sometimes the diameter from the umbo to the ventral margin is greater than in the opposite direction, but not often so. Brander's figure is a deviation in excess. I have been unable to find the type specimen from which his figure was taken, but, from the general accuracy of his other species, it was most probably a faithful representation, and in my own cabinet is a specimen somewhat approaching that form; so that the above name is considered to be applicable to this common Barton shell.

Specimens have in general from 18 to 24 ribs, and the spaces between them equally divide the surface of the shell; the ribs are generally smooth, and so are sometimes the interspaces, but they occasionally show numerous and close imbrications, and the surface is covered with fine curved and diverging striæ, most conspicuous between the ribs.

The auricles are unequal in size; the one on the pedal side of the right valve is large, and has six or seven scaly rays, the upper, as usual, larger and more distant, and at the base of this is a considerable sinus for the byssus, with ridges or denticles on the body of the shell, varying from four to ten; the other auricle is also rayed. The muscle-marks are not immediately or strictly in opposition; they are situated higher up or nearer the hinge in the right valve, and lower down or more in the centre in the left, but it is so with several species in this genus.¹

¹ Some species exhibit more than ordinary variation in individuals, diverging in form far beyond what is shown in any proximate species; others, living under the same (apparently) adverse circumstances, are not affected in a similar manner, but preserve a uniformity of character without any deviation, showing an inaptitude to change under similar conditions. Where bivalve shells have displayed the greatest aberration from what is presumed to be the normal form or typical outline, the change seems to me rather to have been more towards a concentration, as it were, so that a variety of a bivalve, whose typical form would have proportions of length greater than height, would be most shown in a deviation from that type, by a reduction of length with a tendency to the orbicular. An orbicular shell in its deviations would, on the contrary, be rather in the direction of an enlargement or extension in its height. I might mention two or three Crag forms that strongly exhibit this tendency, viz., *Venus casina*, *Cardita senilis*, and *Mya truncata*; but this variation seems to be from a failure of vigour, as the abnormal form is generally rare.

M. Deshayes, in speaking of the Paris Basin shell, *P. plebeius*, says it is variable, with 20 to 28 ribs, and he makes two varieties.¹ M. Nyst says of *P. reconditus*, from Belgium, that he has seen but one valve, and this, judging from his figure, does not differ from our shell. The specimens from Bracklesham, (as I have elsewhere said), figured by Mr. Sowerby, and assigned with doubt to *plebeius*, most probably belong to *30-radiatus*.

There appears to be less variation of form in those bivalve shells whose outline is circular or lenticular than there is in those whose normal condition is more elongated. Pectens are, in general, I think, uniform in outline; and when a specimen like the one figured by Brander presents so great a difference, there is more reason to consider it as belonging to a distinct species, than as a variety of one that is orbicular; and it was only after long and careful examination that I could, on that supposition, bring myself to believe it to be only a variety. Brander's figure may, however, be the representation of a distinct species; if so, I have not seen it.

9. PECTEN SQUAMULA, *Lamarck*. Tab. IX, fig. 6.

PECTEN	SQUAMULA.	<i>Lam.</i> Ann. du Mus., t. viii, p. 354, No. 3, 1806.
—	—	<i>Id.</i> Hist. des An. s. Vert., t. vi, p. 183, No. 27.
—	—	<i>Desh.</i> Coq. Foss. des Env. de Par., t. i, p. 304, pl. 45, figs. 16—18.
—	—	<i>Id.</i> An. sans Vert. du Bassin de Par., t. ii, p. 74, 1860.
—	—	<i>Id.</i> , 2d edit. Lamk., t. vii, p. 164, No. 34, 1836.
—	—	<i>D'Orbigny.</i> Prod. de Palæont., t. ii, p. 326, No. 528, 1850.
—	—	<i>J. Sow.</i> in Dixon's Geol. of Sussex, pp. 94, 172, pl. 3, fig. 29, 1850.
—	—	<i>Morris.</i> Cat. Brit. Foss., p. 179, 1854.
—	SQUAMULOSUS.	<i>Desh.</i> Ency. Meth. Vers., t. iii, p. 717, No. 7, 1832.

Spec. Char. *P. testá minimá, rotundatá, depressá, æquilaterali, æquivalvi; extùs lævissimá, intùs octo ad decem costatá; auriculis magnis, subæqualibus.*

Shell minute, rounded, depressed, equilateral, equivalve; very smooth externally, inside with eight to ten costæ; ears large, slightly unequal.

Diameter, $\frac{1}{8}$ th of an inch.

Localities.—Bracklesham, Bramshaw (*Edwards*).

France, Chaumont et Laon (*Desh.*)

This is exceedingly rare; I have seen it only in Mr. Edwards's cabinet. It is a miniature representation of *P. pleuronectes*, and, like that species, is externally smooth, and

¹ The shell from the Paris Basin appears to differ from our species. In some specimens of *plebeius*, in Mr. Edwards's cabinet, sent to him by M. Deshayes, the rays are smooth at the top, rounded and imbricated at the sides, and I cannot see the fine curving and diverging striæ between the ribs which are so distinct in *P. reconditus*.

has its rays or costæ upon the inner surface: the exterior seems to have been glossy, and the left valve was probably ornamented with colour in zigzag, somewhat like *P. similis*; the shell is extremely thin, and the internal costæ can be distinctly seen on the outside. The auricles are large, as is usually the case in minute species of this genus, and the one on the pedal side is the larger of the two; this in the right valve is rounded at the angles, and ornamented with about half a dozen elevated and imbricated rays, and sinuated near its junction with the shell. In the left valve, the auricle on the pedal side is also larger, but it is neither rounded at its upper angles, nor sinuated beneath. It is most probably identical with the Paris Basin shell, and is not very distantly related to another small fossil species, *P. squama*, Scac. (*P. pygmæus*, Münst.), but this is said to be furnished with as many as twenty rays on the inside of the valves. The figure with this name in 'Goldf. Pet. Germ.,' pl. 99, fig. 6 *a, b*, appears a larger shell; but it has the same number of internal ribs, and corresponds in other respects. Nilsson, 'Petrificana Suecana,' p. 24, t. ix, fig. 18 A B, describes a species, *P. inversus*, which is intermediate in size between *squamula*, Goldf., and *pygmæus*, Münst.

Pecten squamula (Geinitz 'Charak. der Schicht und Petr. des Säch. Böhm Kreid,' p. 83, taf. xxi, fig. 8) is altogether a different species.

10. PECTEN 30-RADIATUS, *J. Sowerby*. Tab. IX, fig. 4, *a—h*, and Tab. VIII, fig. 8.

PECTEN 30-RADIATUS.	<i>J. Sow.</i>	in Dixon's Geol. of Suss.,	p. 172, t. 3, figs. 30, 31, 1850.
— 40-RADIATUS.	<i>Id.</i>	- - - - -	p. 173, fig. 33.
— PLEBEIUS.	<i>Id.</i>	- - - - -	p. 172, figs. 28; 32.
— MULTISTRIATUS?	<i>Morris.</i>	Cat. Brit. Foss.,	p. 178, 1854.

Spec. Char. *P. testá variabilis, æquivalvi, orbiculari, radiatim costatá, costis numerosis, rotundis vel angulato-sulcatis; interstitiis interdum squamulis, minimis, asperatis; quandoque radiatis; auriculis inæqualibus.*

Shell variable, equivalve, orbicular, with numerous ribs, rounded or subangulated; interspaces sometimes with small, rough scales or lines of growth, sometimes with an intermediate ray; auricles unequal.

Diameter, $1\frac{5}{8}$ ths inch.

Localities. Bracklesham, Bramshaw (*Edwards*).

The deposit at Bracklesham Bay has yielded an abundance of specimens belonging to the genus *Pecten*, and these present an unusual amount of variation, rendering a specific determination a task of extreme difficulty. Mr. Edwards had previously examined his specimens; the accompanying notes were in his cabinet, and I have his permission to transcribe them:

- “(a) Costæ 24, 25, round, finely imbricated with intermediate costellæ, imbrications continued over the interstices. Interstices deep; shell sub-orbicular.
- (b) Costæ 24—28, round, imbricated; imbrications more distant than in *a*; interstices shallow; costellæ occasional; shell transversely sub-orbicular.
- (c) Costæ 18—32, round, finely imbricated; costellæ occasional; shell nearly orbicular.
- (d) Costæ acute.
- (e) Multistriatus?
- (f) Tripartitus?
- (g) Transversely sub-orbicular, costæ 30, coarsely imbricated.
- (h) Costæ round, smooth.” (*Edwards.*)

My own observations pretty nearly coincide with the above, and my formula will stand thus:

- a.* Ribs 25—32, rounded and smooth, without an intermediate ray. The smoothness may possibly be from attrition or decortication.
- b.* Ribs 24—32, rounded and imbricated, without intermediate ray.
- c.* „ 25—28 „ „ with „ „
- d.* „ 24—28 tripartite, imbricated all over, without intermediate ray.
- e.* „ 24—28 „ „ with „ „
- f.* „ 26—28 acute, subcarinate, and slightly imbricate, without intermediate ray.

Although we have both attempted the above divisions, I fear the lines of separation will be anything but distinct between these variations.

One perfect specimen, with the two valves united, shows the ribs quite smooth and rounded; another, equally perfect, has the younger portion of the shell with smooth ribs, while the outer and older portion is strongly imbricated both over the ribs and between them; and on another specimen the younger portion is imbricated, and the older portion smooth, uniting thus in one individual the characters of what are called varieties. Where the intermediate ray is developed, it is generally most prominent at the margins. I believe the figures of Mr. Sowerby, above referred to, are representations only of varieties of this variable species. The *40-radiatus* I imagine to be one of the lesser number of ribs, with the intermediate ray elevated into a primary one. The diameter of the shell is *generally* a trifle in excess, measuring from the pedilateral to the siphonilateral margin; but in some specimens the proportions are decidedly reversed. The auricles are rather large and

unequal, and are ornamented with about half a dozen (5-7) primary rays, generally imbricated; the two upper often coalesce, particularly in the right valve, beneath which there is a deep sinus.

P. opercularis is mentioned in Mr. Prestwich's list of species, in his paper on the London clay (p. 405, Geol. Journ.), as from Bracklesham. This may perhaps have been a dead specimen of the recent shell, or perhaps a specimen from the newer Tertiaries of that locality; or it may have been a variety of *30-radiatus*. I have seen nothing from the older Tertiaries that can be united with the recent species, *opercularis*.

Pecten subreconditus, D'Orb. (Prod. Pal., 1850, p. 393, No. 1106), is, I think, not an Eocene shell. He refers to 'Sow. Min. Conch.,' pl. 575, figs. 5, 6, which are representations of a Crag specimen of *opercularis*. *P. subreconditus*, Pictet (pl. 83, fig. 10), who refers to D'Orbigny, is probably the same.

LIMA, Bruguière, 1792.

Generic Character. Shell ovate, equivalve, generally inequilateral; the pedal region oblique and gaping. Sometimes the shell is straight and equilateral; exterior occasionally smooth, more often radiately ribbed or striated, rough or squamous. Hinge area triangular, extended into auricles; connexus bipartite, with central pit; adductor impression large, lateral, and double; two small pedal scars.

Animal has the mantle margins disunited, and fringed with a double row of tentacular filaments, the inner one long and pendulous; ocelli inconspicuous; foot small, finger-like, furnished with a byssal groove.

Several divisions have been made of the shells that will come into the above formula.

Limea has been proposed for those species which have a row of teeth or crenulations upon the hinge margin, and *Limatula* for those which are equilateral and closed.

In general, the oblique species (*Lima* proper) have one side straight, and the other rounded, with one opening; but this is by no means constant, as there is often a large gape on both sides. The shell of *Limatula* has sometimes a row of crenulations, while the same form of shell is known to be without them. *Limea*¹ has teeth on each side of the cartilage-pit upon the hinge-margin; these are sometimes in a rectangular position, at others they are placed obliquely to the hinge-line, and these are generally upon shells that are equilateral or nearly so, but they are not confined to that form of shell; and in the oblique species there

¹ Goldfuss has figured two species of Secondary fossils, one from the Lias, *L. acuticosta*, pl. 107, fig. 8, with large dentations.

is often a large distinct tooth in one valve, that interlocks into a depression in the other. M. Loven, in speaking of the animal of *Limea Sarsii*, says that the margin of the mantle is destitute of those tentacular filaments which form so rich an ornament to the animal of *Lima hians*.

In the fossil genus *Plagiostoma*, there is a large gape on the rounded or siphonal region; but this distinction is by no means a generic one, as the same character may be seen in shells of the living species of *Lima* proper.

Some of the animals of this genus spin a byssus, and are said to be fixed; but others are able to swim with considerable vigour, like the *Pectens*, by opening and rapidly closing or flapping their valves. The animal of *Lima hians* is a most beautiful object, sometimes of a deep crimson colour, with an orange-coloured mantle; and it makes an artificial burrow with fragments of coral, shells, and sand. The recent shell of this genus is always white, and, according to Dr. Carpenter, its outer layer consists of coarsely plicated, membranous lamellæ; the inner is perforated by minute tubuli, forming a complete network.

This is wholly a marine genus, and the species are found in various parts of the world, from Norway to India, Australia, and the West Indies, and they present no special indication of climate. Mr. McAndrew obtained the largest living species, measuring $5\frac{1}{2}$ inches in height and $4\frac{1}{4}$ long (*excavata*, Chemn.), on the coast of Finmark, and the European species possess a vertical range from 1 to 150 fathoms. A Permian fossil strongly resembles this genus, and it has continued through all the Secondary periods in large numbers; the Tertiaries are somewhat scantily supplied.

1. LIMA COMPTA, *S. Wood*. Tab. XI, fig. 5.

Spec. Char. *L. testá tenui obovatá, valdè obliquá, subdepressá, inæquilaterali; striatá vel costulatá, striis vel costulis numerosis, angustis, regularibus, acutis, scabris; auriculis magnis æqualibus; cardine angusto, recto, simplici; umbonibus acutis, subprominentibus.*

Shell thin, obovate, very oblique, somewhat depressed, inequilateral, striated or costulated, striæ or riblets numerous, narrow, sharp, regular, and rough; auricles large and equal; hinge-line straight, with pointed and rather prominent beaks.

Longest diameter, $\frac{3}{4}$ of an inch.

Locality. Barton (*Edwards*).

One specimen is all that I have seen, and this is not quite perfect; but it differs from any species I am acquainted with, as indicated by the lines of growth. I believe it to be distinct. The entire surface of this shell is covered with radiating striæ, and these are numerous and regular. It somewhat resembles *L. tenuis*, Desh. (An. sans Vert. du Bassin de Par., t. ii, p. 67, pl. lxxviii, figs. 20—22); but it is more oblique than that figure, having the umbo incurved, and not so prominent; there is also, seemingly, a deeper sinuation under the auricle in the siphonilateral margin, and the rays upon our shell are more numerous and less regular.

2. LIMA EXPANSA, *J. Sowerby*. Tab. XI, fig. 6.LIMA EXPANSA. *J. Sow.* in Dixon's Geol. of Sussex, pp. 94, 172, t. 3, fig. 34, 1850.— — — *Morris*. Cat. Brit. Fossils, p. 172, 1854.

Spec. Char. *L. testá parvá, obliquè orbiculari, subtransversá, tenui, fragili, subæquilaterali, depressiusculá; extùs striis radiantibus ornatis, interstitiis punctatis; cardine brevi, auriculis minimis, subæqualibus.*

Shell small, obliquely orbicular, slightly transverse, thin, fragile, and subequilateral; externally ornamented with about 40 rays, interstices punctated; hinge short, with small, nearly equal auricles.

Diameter, $\frac{1}{4}$ of an inch.

Locality. Bracklesham (*Edwards*).

"Much more orbicular than any other *Lima* I know, but much too oblique for a *Pecten*. It is extremely rare. Mr. Edwards has one nearly perfect valve, and Mr. Dixon a fragment." (*Sowerby*.)

This small shell somewhat resembles in outline *L. dilatata*, Desh. Coq. foss. de Par., p. 298, pl. xliii, figs. 15—17. Our shell has about 40—42 rays, which are broad and flat, the interspaces narrow, and prettily ornamented with transverse projecting ridges, between which are rounded and deep punctations. The hinge-area in Mr. Edwards' specimen is broken and not very distinct; it was probably small, with small auricles.

3. LIMA SOROR, *S. Wood*. Tab. XI, fig. 7, *a, b*.LIMA OBLIQUA. *Morris*. Catal. Brit. Foss., p. 172, 1854.

Spec. Char. *L. testá ovato-elongatá, obliquá, inæquilaterali, tenui, striatá, pedi-regione lævigatá; striis angulatis, irregularibus; umbonibus parvis, acutis; auriculis minimis, brevibus, æqualibus.*

Shell ovately elongate, oblique, inequilateral, thin, striated, with small angular and irregular ribs or riblets; beaks small and pointed, auricles short and equal.

Longest diameter, $\frac{7}{8}$ ths of an inch.

Locality. Highcliff, Barton (*Edwards*).

There are two specimens of this species in Mr. Edwards' cabinet, and they are in a sufficiently perfect condition to show a considerable, and what I presume is a specific, difference from *L. obliqua* of Deshayes, if I may judge from figures and descriptions of that shell.

In the 2d ed. of Lamarck, tom. viii, p. 120, the author says, "toute sa surface est couverte de striæ longitudinales."

In the present species, the pedal region, from the margin to the elevated ridge or most tumid portion of the shell, is quite free from striæ of any kind; and on the centre the striæ are small, close, and numerous, becoming larger and wider as they diverge from the middle towards both regions; the hinge-line is short, and there is a small gape or sinuation in the siphonilateral margin immediately under the auricle; the umbo is small, sharp pointed, but not very prominent, unlike that represented in the French shell, which has also apparently a greater height. With these differences, I have ventured to propose for the English fossil a new name.

SPONDYLUS. *Linn.*, 1767.

SPONDYLUS. *Rondelet*, 1555. *List.*, 1686.

SPONDYLITES (sp.). *Aldrov.*, 1648.

ARGUS ET ARGODERMA (sp.). *Poli*, 1795.

PLAGIOSTOMA (sp.). *Lamk.*, 1819.

DIANCHORA. *J. Sowerby*, 1814.

PODOPSIS. *Lamk.*, 1819.

PACHYTOS. *DeFrance*, 1825.

PACHYTA. *Menke*, 1830, fide *Herrm.*

PACHYTUS. *Agass.*, 1847.

Generic Character. Shell irregular, generally thick and strong, and attached by the right valve; ribbed or costated radiately; more or less spiny or foliaceous; eared; umbones often remote; lower or attached valve with a triangular hinge-area; connexus bipartite, cartilagenous portion between two curved interlocking teeth in each valve; impression by the adductor double.

Animal with the edges of the mantle disconnected as in *Pecten*, and furnished with two rows of tentacular filaments; foot small, cylindrical, truncated.

The species of this genus in the recent state are about thirty, and these are distributed over the globe, but mostly in tropical or subtropical regions; many of these are beautifully coloured, and highly ornamented with spines or broad foliaceous projections; these appendages are sometimes long and pointed, while at others they are merely rudimentary spines. These shells are known by the name of spiny oysters, but they are wholly distinct from the genus *Ostrea*, and approach nearer to *Pecten*, which they resemble in some characters. The hinge-area is furnished with prominent denticles, two in each valve; those in the lower are small, and situated close to the cartilage; the two teeth of the upper valve are more remote, and lock into depressions outside the smaller teeth of the lower valve. The connexus is more or less internal, opening the shell by

expansion; but in many it is bipartite, extending outwardly in a furrow, like the oyster; a small ligament sometimes occupies the hinge-margin, and this margin is occasionally rugose or faintly denticulated. The lower valve is generally the most spiny, and in the recent state is nearly colourless; this is the right valve, and the one by which it is most frequently attached. Many fossil species are known, commencing low in the Secondary series. The structure of the shell in some of the species has long been noticed as being composed of two different layers (and in the recent shells of two different colours), the inner being very distinct from the outer, and very destructible.

This genus in the fossil state is supposed to indicate, for the formation in which it is found, somewhat of a tropical character; it may be so as a general rule, but three species are found at the present day, in the Mediterranean, in association with northern forms. It is purely a marine genus, and the living species are generally found in deep water.

SPONDYLUS RARISPINA, *Deshayes*. Tab. VIII, fig. 1, *a*, *b*.

SPONDYLUS RARISPINA.	<i>Desh.</i>	Coq. Foss. des Env. de Par., p. 321, pl. 46, figs. 6—10.
—	<i>Id.</i>	An. sans Vert. du Bassin. de Par., t. ii, p. 90, 1860.
—	<i>Nyst.</i>	Coq. Foss. Belg., p. 308, pl. 25, fig. 4 <i>b</i> , 1843.
—	<i>D'Orbigny.</i>	Prod. de Paléont., t. ii, p. 393, No. 1116, 1850.
—	<i>Morris.</i>	Cat. Brit. Foss., p. 182, 1854.
—	<i>Pratt.</i>	Proc. Geol. Soc., vol. iv, p. 158, 1843.
—	<i>D'Archiac.</i>	Tr. Geol. Soc. Fr., 2d ser., t. iii, pt. ii, p. 437, 1850.
—	<i>J. Sow.</i>	in Dixon's Geol. of Suss., p. 173, 1850.
—	<i>Bellardi.</i>	Mém. de la Soc. Géol. de Fr., 2d ser., t. iii, p. 260, 1852.
—	<i>Id.</i>	Catal. ragionato dei foss. Numm. d'Egitto, p. 26, No. 66, 1854.

Spec. Char. *Sp. testá ovato-rotundatá, obliquá, brevi-auritá; sulcis vel costis radiantibus, numerosis; majoribus spinis, raris, echinatis, alteris subæqualibus muticis.*

Shell roundly ovate, oblique, with small auricles, covered with numerous radiating striæ or riblets, the larger having distant spines or imbrications.

Longest diameter, $1\frac{1}{2}$ inch.

Localities. Bracklesham (*Edwards* and *Dixon*).

Belgium, les sables d'Uccle, de St. Gilles, et de Dieghem (*Nyst*).

France, à Chaumont (*Deshayes*), Biaritz (*D'Arch.*), Nizza (*Bellardi*).

I have seen only two specimens of this species, and those are both of the left or free valve. Both these specimens are alike oblique in form; the larger rays are sparingly covered with small spines or imbrications, and between these are three, sometimes two, intermediate rays, which are generally smooth. This valve is much depressed; the right or adherent one was probably tumid. The hinge is strong, and in this valve there are

deep and large depressions for the reception of the teeth of the opposite one. Auricles small. The muscle-mark is large, rounded, and eccentric. This species strongly resembles *Sp. Cisalpinus*, Brongniart, and may probably (as suggested by M. Deshayes) be only a strongly marked variety of that shell.

AVICULA. *Klein, 1753.*

Gen. Char. Shell inequivalve, inequilateral, obliquely oval; left valve the larger or more tumid, right valve with a byssal sinus; cartilage-pit oblique; hinge sometimes edentulous, at others with one or two small cardinal teeth, and an elongated lateral one; hinge-line rectilinear, with the extremity generally prolonged; muscular impressions large, subcentral; pedal scar high in the umbonal region; impression of the mantle entire; connexus ligamentous.

Animal obliquely triangular; the edges of the mantle disunited, except at one point where the juncture separates the incoming from the outgoing canals; margins fringed, and furnished with a pendant curtain; foot small, subcylindrical, or digitiform, grooved; byssus sometimes solid, with an expanded termination.

There is much difficulty in assigning a proper limit to this genus, which has so many near relations. Conchologists are greatly at variance as to what should be included within its generic boundaries. The hammer oyster (*Malleus*), a recent shell, with an extension of the hinge-margin on each side of the umbo, has been considered as not entitled to generic distinction; the young shell being extended only on one side, and it is then very like a true *Avicula*. There are also some fossils of the older rocks which bear a very strong resemblance; these have been elevated into genera, under the names of *Pterinea*, *Pteronites*, *Pteroperna*, *Ambonychia*, &c., each presenting some small distinctive character. The claim of *Meleagrina* to isolation appears to rest upon a less extended hinge-margin, than that which, in the type of this genus (*Mytilus hirundo*), gives such a winged-like form to that shell; this appendage is exceedingly variable in different species, and indeed is of different lengths in the individuals of the same species, the young differing from the parent shell; while also among the full-grown specimens, this character is by no means permanent in the same species. The form of the shell, divested of its extended hinge-line, bears a strong resemblance to that of *Mytilus*.

The connexus in this genus is in general simple, and spread over a large external area.

Twelve or thirteen species have been described from the French Eocene deposits, and a few from the more recent formations.

The only species of this genus now found on our own coasts and in the Mediterranean ranges, in the latter sea, according to Mr. M'Andrew, from eight to thirty-five fathoms.

1. AVICULA ARCUATA, *J. Sowerby*. Tab. XI, fig. 3.AVICULA ARCUATA. *J. Sowerby*. Geol. Trans., 2d ser., vol. v, t. 8, fig. 15, 1834.— — *Morris*. Cat. Brit. Foss., p. 163, 1854.

Spec. Char. *Av. testá elongatá, obliquá, arcuatá, compressá, lævigatá, tenui; valdè inæquilaterali.*

Shell elongate, oblique, and curved, compressed, smooth, thin; very inequilateral.

Longest diameter, $\frac{3}{8}$ ths of an inch.

Locality. Hampstead (*Wetherell*).

All that I have seen is the unique specimen in Mr. Wetherell's cabinet. It appears to be distinguished by its curved form. *A. microptera*, Desh. (p. 290, pl. 43, figs. 18—20), resembles it in some characters, but is not so much curved.

2. AVICULA MEDIA, *J. Sowerby*. Tab. XI, fig. 1, *a—d*.AVICULA MEDIA. *J. Sow.* Min. Conch., t. 2.— — *Prestwich*. Geol. Journ., 1847, p. 401.— — *Morris*. Cat. Brit. Foss., p. 163, 1854.— — *Wetherell*. Phil. Mag., p. 464, 1836.— — *D'Orb.* Prod. de Paléont., t. ii, p. 391, 1850.

Spec. Char. *Av. testá inæquivalvi, ovato-trigoná, valdè obliquá, lævigatá, fragili; valvâ sinistrâ convexâ, tumidâ; valvâ dextrâ depressiore; umbonibus prominentibus, remotis; areâ cardinali magno.*

Shell inequivalve, ovately trigonal, very oblique, smooth, and fragile, nacreous; left valve convex and tumid; right valve more depressed; umbo prominent, with a large and broad cardinal area.

Diameter, length 2 inches, height $1\frac{1}{2}$ inch.

Localities. *a, b, d*, Brockenhurst. *c*, Barton, Bracklesham, Hampstead (*Edwards*). Highgate, Chalk Farm, Potter's Bar (*Wetherell*). Sheppey, Basingstoke, Newnham (*Prestwich*).

This is by no means rare, and the specimens present a large amount of variation. In some individuals, the length of the hinge-line extends so far as to be perpendicular to the basal margin on the siphonal side, while in others this sub-auricle, if it may be so called, is considerably shorter. The Barton specimens are generally the more oblique, though not always so; the specimen figured from Brockenhurst is somewhat quadrate, and corresponds in that character with the specimens figured in 'Min. Conch.,' from Highgate. It is seldom that the outer surface is preserved, but in one specimen

from Barton, in which it is so, the right or flatter valve exhibits faint radiations; in one specimen of Mr. Edwards, (fig. 1, *c*,) of the left valve, these radiations are not visible, although the outer layer is well preserved and perfect, showing irregular and lamellated and somewhat undulating lines of growth.

3. AVICULA PAPYRACEA, *J. Sowerby*. Tab. XI, fig. 2, *a—c*.

AVICULA PAPYRACEA. *J. Sow.* Geol. Tr., 2d ser., vol. v, pl. 8, fig. 16, 1834.

— — — *Morris.* Cat. Brit. Foss., p. 164, 1854.

Spec. Char. *Av. testá tenuissimá, papyraceá, obliquá suborbiculari, compressá, concentricè costulatá aut undulatá; auriculis minimis, inæqualibus.*

Shell very thin, papyraceous, obliquely orbicular; much compressed; concentrically ridged or waved; ears small, unequal.

Longest diameter, $1\frac{1}{2}$ inch.

Localities. *b*, Hampstead, Sheppy, Primrose Hill (*Wetherell*). *f. a.* Haverstock Hill (*Edwards*).

“An extremely thin, pearly shell, sometimes assembled in considerable masses.” (*Sowerby*.) Although specimens are by no means rare, the shell is always compressed and distorted; indeed, all I have seen are literally flat. In outward form it is unlike the generality of shells of this genus, in having the hinge-line but little developed; it resembles a *Posidonia* in that character. A specimen in the Museum of the Geological Society, apparently belonging to this species, is marked Southend (*Warburton*).

PINNA. *Linnæus*, 1767.

Generic Character. Shell equivalve, cuneiform, or wedge-shaped; umbones at the pedal extremity, siphonal region truncated and gaping; connexus ligamentous, linear; hinge edentulous; adductor muscle-mark subcentral, large, ill defined.

Animal the shape of the shell; the margins of the mantle with a double fringe, and disunited except at the dorsal edge; foot elongated, grooved, spins a large, powerful, and silky byssus; attached by triple muscles to the centre of each valve.

This is a marine genus. The species range from low-water mark to sixty fathoms, and the animals live generally buried in the sand or mud, with the pointed end of their valves inserted; they are gregarious, large numbers congregating in one spot.

The composition of the shell in this genus appears to be different from that in most of the Mollusca, and, according to Dr. Carpenter, is made up of two very differently constituted portions. The outer or larger part of the shell is cellular, or composed of fibrous material,

placed at right angles to the surface, while the inner is laminated; and as these laminæ are placed in an irregular, or rather in an undulating or wavy manner, they produce the shelly substance called nacre, which, it appears, is more susceptible of destruction than the outer or fibrous portion, and this in many of the secondary fossils is the only part of the shell which is preserved. The fibrous portion being very fragile, the shell separates readily into fragments; and it is, therefore, a fossil not generally found in a perfect condition. There is also another peculiarity in the shell, being, as it were, divided by a line down the middle, from the pedilateral to the siphonilateral margins, where it will readily crack: so that fossils have frequently become of a quadrate form; such, for example, as *Pinna tetragona*, which has assumed that shape from pressure alone. Many of the species of this genus will show, more or less, this tendency to angularity on the outside of the valves. The pearly or nacrous lining seldom extends more than half-way from the beak; frequently not so far. Many of the species attain to large proportions. *Pinna nobilis*, of Poli, an inhabitant of the Mediterranean, has a shell that is said to measure three feet and a half. This genus is as old as the Carboniferous Limestone, or perhaps the Devonian; so far, of course, as can be determined by the shell alone; and it existed through the intermediate periods, though not anywhere in great abundance. One of the aberrant forms found in the Oolites has been thought, by Messrs. Morris and Lycett, to have a difference sufficient to justify a generic separation, and they have adopted for it the name of *Trichites*; the history of which, and the reasons for adoption, are given by these authors in their valuable monograph of the Oolitic Bivalves. The principal difference existing between the Oolitic shell and the true *Pinna* is in the inequality of the valves.

Pinna is on the verge of the ordinal division; it more strictly belongs to the *Dimyaria*, having two adductor muscles, but one is so near to the pointed extremity of the valves as to be used more as a connector than as an adductor, while the other, the really useful one, is situated quite in the centre of the shell.

1. *PINNA AFFINIS*, *J. Sowerby*. Tab. X, fig. 1, *a—c*.

- | | | |
|----------------|----------------|--|
| PINNA AFFINIS. | <i>J. Sow.</i> | Min. Conch., t. 313, fig. 2, 1821. |
| — | — | <i>Mantell.</i> Geol. Tr., 2d series, vol. iii, pt. i, p. 203, 1829. |
| — | — | <i>Wetherell.</i> Phil. Mag. and Journ., vol. ix, p. 464. |
| — | — | <i>Nyst.</i> Foss. Belg., p. 275, 1843. |
| — | — | <i>J. Sow.</i> in Dixon's Geol. Sussex, pp. 31, 117, 172, 226, 1850. |
| — | — | <i>Morris.</i> Cat. Brit. Foss., p. 179, 1854. |
| — | — | <i>D'Orbigny.</i> Prod. de Paléont., t. ii, p. 391, 1850. |

Spec. Char. *P. testá cuneatá, trigoná, regulari, costatá; apice acuto; siphoni-regione truncatá; costis divergentibus; margine dorsali recto, margine ventrali sub-arcuato, simplici.*

Shell cuneiform or wedge-shaped, regularly trigonal; apex acute, truncated at the

extremity of the siphonal region, and ornamented with diverging ribs; dorsal margin straight, ventral margin slightly curved.

Length.—9 to 11 inches.

Localities.—Highgate, Whetstone, Chalk Farm (*Wetherell*), Sheppey, Newnham (*Prestwich*), Bognor, (*Edwards*).

Our shell is ornamented with about sixteen or eighteen rather elevated rays or costæ, slightly imbricated, and sometimes undulating, with occasionally a small intermediate ray.

This species appears to have possessed a habit similar to that sometimes seen in species of *Modiola*; two or three specimens are found together, the one enveloping the other. A young fry probably occupies the shell of its parent, which it has never left, and perhaps grows to its full size where it was born, filling entirely with its own shell the one previously occupied by the mother. Mr. Edwards' specimen shows this intimate union of three individuals, each as nearly as possible of the same size. An imperfect specimen of this species in the Museum of the Geological Society indicates a length of twelve inches

2. PINNA ARCUATA, *J. Sowerby*. Tab. XI, fig. 8.

PINNA ARCUATA.	<i>J. Sow.</i>	Min. Conch., t. 313, fig. 3.
—	—	<i>Prestwich</i> . Journ. Geol. Soc., 1847, p. 405.
—	—	<i>Morris</i> . Catal. Brit. Foss., p. 180, 1854.
—	—	<i>D'Orbigny</i> . Prod. de Paléont., t. ii, p. 391, 1850.

“Nearly equilateral, ventricose, finely ribbed, arched.”

Longest diameter, $\frac{3}{4}$ ths of an inch.

Locality.—Highgate (*J. Sowerby*).

“Nearly as deep as long; the hinge-line is gently curved; the opposite edge much arched; in other respects, this strongly resembles the last.”

“Having several specimens of this arched *Pinna* from Highgate, exactly alike as well in curvature as in size, I cannot but consider it a distinct species. It appears to be quite different from *P. incurva*, Linn.: it occurs in *Septaria*.” (*Sowerby*).

The figure above referred to, and the description, are taken from ‘Min. Conch.’

3. PINNA MARGARITACEA, *Lamarck*. Tab. XI, fig. 9.

PINNA MARGARITACEA.	<i>Lam.</i>	Ann. du Mus., t. vi, p. 218, and t. ix, t. 17, fig. 8.
—	—	<i>Defrance</i> . Dict. des Scien. Nat., t. 41, p. 71.
—	—	<i>Desh.</i> Coq. Fos. des Env. de Par., t. i, p. 280, pl. 41, fig. 15.
—	—	<i>Id.</i> An. sans Vert. du Bassin de Par., t. ii, p. 35, 1860.
—	—	<i>Nyst.</i> Coq. Foss. Belg., p. 274, pl. 20, fig. 9.
—	—	<i>J. Sow.</i> in Dixon's Geol. of Sussex, pp. 94, 117, 172, 226.
—	—	<i>Morris</i> . Catal. Brit. Foss., p. 180. 1854.

Spec. Char. “*Testá elongatá, cuneiformi, trigoná, angustá, sublævigatá, vel sulcis longitudinalibus, superficialibus, undulatis instructá, extùs fuscá, fibrosá, intùs albá, margaritaceá.*”

“Shell elongate, wedge-shaped, trigonal, nearly smooth, or with superficial and longitudinally undulating rays, externally brownish or dusky and fibrous, within white and nacreous.”

Length, ?

Localities.—Bracklesham (*Dixon*), Highgate (*Sowerby*).

France, Grignon, Parnes (*Desh*).

“This appears to have sharper ribs than *P. affinis*, but probably they are the same species differently preserved.” (*J. Sowerby*.)

Our figure is taken from a specimen in the British Museum in the late Mr. Dixon's collection; this species appears to have more numerous and finer rays than any I have seen upon the young state of *P. affinis*.

4. PINNA PYRIFORMIS, *S. Wood*. Tab. X, fig. 2, and Tab. XI, fig. 10.

PINNA — n. s. *Prestwich*. Quart. Journ. Geol. Soc., vol. iii, p. 370, 1847.

Spec. Char. *P. testá tenui, tumidá, inflatá, infundibuliformi, costatá; costis numerosis, subundulatis; margine dorsali subrectá; margine ventrali incurvá.*

Shell thin, tumid, or inflated, funnel-shaped, costated; ribs numerous, thin, and slightly undulating; dorsal margin nearly straight, ventral margin curved.

Length, ?

Locality. Cuffell, near Basingstoke (*Prestwich*).

The specimen figured is from the cabinet of Mr. Prestwich, and I coincide in his opinion that it is specifically distinct; it is unlike any other species that I have seen. It differs from *P. affinis* in form, and it approaches nearer to *P. arcuata*; but it is not so curved as that species, either in the dorsal or ventral margin, and it is considerably more expanded than either of those species. A small portion only of the shell is left, and the rays are nearly obsolete; what there are remaining appear to have been smaller and more numerous, and also more equal, than those of *affinis*, but its presumed distinction is founded upon the expanded character. I cannot but imagine this to be natural, for although there is a tendency in many species of this genus to become inflated by a collapse or fracture in the centre, I do not see in this any angularity, but a regular curvature in the valves.

DREISSENA. *Van Beneden*, 1834.

MYTILUS. *Lam. and Goldf.*
 ENOCEPHALUS. *Münst.*, 1831.
 MYTULINA. *Cantraine*, 1834.
 DYTHALMIA. *Jay*, sec. *Gray*.
 TICHOGONIA. *Rossmesler*, 1835.

CONGERIA. *Partsch*, 1837.
 MYTILOMYA. *Cantraine*, 1837.
 MYTILIMERIA. *Conrad*, 1837.
 COELOGONIA. *Bronn* (laps. calam.), 1837.
 ÆNOCEPHALUS. *Herrm.*, 1846.

Generic Character. Shell equivalve, inequilateral, ovately trigonal or obscurely wedge-shaped; umbones terminal, pointed; hinge edentulous; valves obtusely keeled, with a slight byssal sinus; one muscular impression, immediately beneath the umbones, supported upon a shelf, projecting inwardly; impression of pedal muscle single; anal adductor large, excentric; connexus bipartite.

The animal (*Mytilus polymorphus*) with the mantle closed, except for the foot and byssus. Siphons unequal; anal opening small, conical, and plain; branchial opening prominent and fringed; foot-muscle short and thick.

The name of *Enocephalus* of Münster seems to have priority of date, but, according to M. Bronn, it was merely given to the shell without figure or description; it therefore yields to a subsequent claim, and this is divided between *Mytilina*, Cantraine, and *Dreissena*, Van Beneden; both of which names were proposed for the shell in the same year. Bronn has awarded the right to Van Beneden, who, he says, is entitled to priority. The name is also in general use.

This is a fresh-water mussel; the typical species, *Myt. Volgæ*, Chemn., is a native of the Aralo-Caspian rivers, whence it has been brought to this country on foreign timber, and it has now become naturalised with us. It differs principally from *Mytilus* in having a calcareous plate immediately under the umbo; in other respects it resembles the general form of the mussels. M. Nyst enumerates fourteen species, eight of which are fossil from the Tertiaries of Germany, France, Belgium, and the Crimea; but a fossil said to belong to this genus has been found in the coal measures. The species, though probably more inclined to fresh-water, were capable of living in estuaries where the water was salt.

This, like the genus *Unio*, is very variable in regard to the solidity or substance of the shells of different species; some are thick and heavy, while others are quite the reverse. This is, perhaps, truly Dimyarian, with two adductor muscles, and the animals possess distinct but short siphonal tubes, indicating, by the inflexion in the mantle-mark, probably a slight difference in their extent of protrusion.¹

¹ *Dreissena* is said to be distinguished from *Mytilus* as much by the intimate structure of the shell as it is by other characters.

DREISSENA BRARDII, *Faujas St. Fond.* Tab. XII, fig. 3, *a—c*.

MOULE. *Fauj. St. Fond.* Ann. du Mus., t. viii, t. 58, figs. 11, 12.

MYTILUS BRARDII. *Brongn.* Terr. calc. Trap. du Vincentin, t. 6, fig. 14, 1823.

— — *Goldf.* Petr. Germ., vol. ii, p. 271, t. 129, fig. 10.

— — *J. Sowerby.* Min. Conch., t. 532, fig. 2, 1826.

— — *Bronn.* Leth. Geog., t. ii, p. 923, pl. 39, fig. 10, 1836.

— — *Nyst.* Rech. Coq. foss. Hoess. et Kl. spaw., p. 13, No. 22, 1836.

? — — var. β ? *Basterot.* Bordeaux Foss., No. 2, p. 78.

? — BASTEROTII. *Dujardin.* Tr. Géol. Soc. Fr., vol ii, p. 269.

? — ACUTIROSTRIS. *Goldf.* Petr. Germ., t. v, pl. 129, fig. 11, p. 272.

? — SPATHULATUS. *Id.* — — — — — fig. 12.

CONGERIA BASTEROTI? *Desh.* Conch., 650, t. 37, figs. 15, 16.

DREISSENA BRARDII. *Morris.* Catal. Brit. Foss., p. 202, 1854.

— — *Pictet.* Traité de Paléont., pl. 81, fig. 11.

— BASTEROTI. *Nyst.* Conch. Foss. Belg., p. 265, pl. 20, fig. 7 *a—c*.

— SOWERBYI. *D'Orbigny.* Prod. de Paléont., t. 11, p. 425, No. 1637, 1850.

Spec. Char. *D. testá ovatá vel elongato-cuneatá; lævigatá, obtusè carinatá; umbonibus acutis; septo cochleato.*

Shell ovate or elongately wedge-shaped, smooth, and obtusely carinated; beaks sharp and pointed; septum concave.

Length, $\frac{7}{8}$ ths of an inch.

Localities. Hordwell, Headon Hill (*Forbes*).

Belgium, Limbourg (*Nyst*), Weisenau, Env. de Mayence (*A. Brongniart*).

This little shell is abundant in the fine sandy stratum at Hordwell which has yielded so many beautiful vertebrate fossils. Upwards of a hundred specimens were obtained by myself, congregated in and around the upper jaw of *Alligator Hantoniensis*. It is possible that the decomposition of the flesh of the dead reptile may have rendered the water at that place favorable to the multiplication of the mussel. I found the shell elsewhere, but in no other place in so great abundance.

My specimens are variable in outline; the proportions in some are from $2\frac{1}{2}$ to 1, while in others they are not more than $1\frac{1}{2}$ to 1, the more elongated being also the more tumid. The umbo is a little inflected, and in some specimens there is a flattening on the siphonal region. The shelf is of a moderate size, and is not entirely occupied by the muscle, the mark of which is indented on it, and is of a roundedly oval shape. The cartilaginous portion of the connexus extended about two fifths of the longest diameter of the shell, and, like that of *Mytilus*, it was nearly covered by the dorsal edge. Many specimens of a small *Serpula (tenuis)* were found with this mussel in association with numerous specimens of *Limnææ*, *Cyrenæ*, &c., and in one of the specimens there is what appears to be the arenaceous case of a *Sabella* (fig. 3 *a*). We have, thus, supposed marine animals living in fresh water with *Limnææ*, or we have the supposed

fresh-water Limnææ in company with salt-water animals, as previously noticed by Mr. James Sowerby in his 'Mineral Conchology.' I am inclined to think the water where these animals were deposited was quite fresh, although Limnææ have been found living in saline marshes; the reptile was probably stopped by a bend of the river or by some impediment in the stream; the presence of a large number of the scales of *Lepidosteus* in this layer of sand indicates the greater probability of its having been more of a fresh-water deposit than brackish.

D. Brardii is given by Mr. Prestwich in his list of the organic remains of the Woolwich and Reading series (Jour. Geol. Soc., 1847, p. 117); he says, however, at p. 120 (*f*)—"this shell is here in too imperfect a state to admit of a positive determination."

Two specimens, with the name of *Mytilus Brardii*, were obligingly sent to me many years ago by the Comte du Chastel, and to these was attached the locality of Bordeaux. I presume they are what have since been called *Dreissena Basterotti*. On a close comparison with the British fossil, these specimens present the following differences: they are rather more pointed, less curved at the umbo, and they have an obtuse elevation or sort of ridge at the most inflated part, which has probably caused them to be called "subcarinated." Whether these slight differences be permanent or whether they are such as will constitute a specific distinction, the few specimens of the Bordeaux shell that I have seen will not permit me to give a decided opinion.

MYTILUS. *Linnaeus*, 1758.

Generic Character. Shell equivalve, wedge-shaped, acuminate, rounded on the siphonal side; umbones pointed, terminal; hinge-teeth few, minute, sometimes obsolete; muscular impression at the umbo small and narrow; pedal impressions two in each valve; connexus bipartite, marginal; interior of shell nacreous.

Animal elongate, with the lobes of the mantle partly fringed, plain in the anal region, and slightly projecting; disconnected except where there is a separation for the siphonal openings; adductor muscles very unequal in size; foot cylindrical, furnished with a gland and groove; byssus strong and coarse.

This genus is generally marine, though sometimes estuary in its habits, and, I believe, *M. edulis* is known occasionally to live with Limnææ, &c., when the water is fresh. This common edible mussel frequents mud banks, and, as it is well known, is more often found where it has been deserted by the retiring tide; others inhabit the sea at considerable depths. In the recent state the genus numbers probably fifty species, and these have a very extensive geographical range, taking in the whole circumference of the globe. The generality of the species are extra-tropical. Fossil species are abundant, and are said to be found in rocks of the Permian age.

1. MYTILUS AFFINIS, *J. Sowerby*. Tab. XII, fig. 1, *a—d*.MYTILUS AFFINIS. *J. Sow.* Min. Conch., t. 532, fig. 1.— — *Morris.* Catal. Brit. Foss., p. 215, 1854.

Spec. Char. *M. testá tenui, elongato-cuneatá vel obliquè-oblongatá, lævigatá, subcarinatá; margine dorsali subrecto; intùs margaritacea; cardine edentato.*

Shell thin, elongately wedge-shaped, or obliquely oblong, smooth, subcarinated; hinge-margin nearly straight; interior pearly; hinge without teeth.

Length, 2 inches.

Localities. *b*, Barton; *a, c, d*, Colwell Bay, Headon Hill, Whitecliff Bay, Hordwell (*Edwards*).

This species much resembles in outline some of the varieties of the common mussel, but it is carinated, that is to say, it is obtusely ridged at the most tumid or inflated part, and it is generally less rounded and more flattened in the siphonal region than in the recent British species; it is also very thin, and quite free from teeth at the umbo. Although not abundant, this fossil presents a good deal of variation in outline, the dorsal margin being much longer in some specimens than in others; but this kind of variability is common to the genus, and it may be seen in excess in the varieties of *M. edulis*.

2. MYTILUS STRIGILLATUS, *S. Wood*. Tab. XII, fig. 2, *a, b*.

Spec. Char. *M. testá minimá, tenui, ovato-cuneatá, obliquá, incurvá, inflatá, radiatim striatá, striis obtusis convexis; margine dorsali arcuatá, et crenulatá; margine ventrali subincurvá; areá cardinali denticulatá.*

Shell small, thin, and ovately wedge-shaped, oblique, incurved, tumid, radiately striated; striæ obtuse, rounded; dorsal margin arched and strongly crenulated; ventral margin slightly concave; hinge-area denticulated.

Length, $\frac{1}{4}$ inch.

Locality. Barton (*Edwards*).

Half a dozen specimens of this pretty little shell appear to offer good distinguishing characters. The connexus was short, and situated within the rounded dorsal margin, but its action was over a fulcrum, and it was probably visible when the valves were closed. There are about half a dozen denticles in the hinge-area, variable in size, the two on the pedal side being the larger, and the dorsal margin outside the ligament is strongly denticulated, like *Modiolarca*. The striæ, or rather ribs which ornament the shell, are large, prominent, and rounded, not angular, and the spaces between them are as broad as the ribs; an intermediate ray may be occasionally seen on the dorsal and siphonal regions as the shell enlarges. This closely approaches *Modiola*, having a trifling extension beyond the umbo.

MODIOLA. *Lamarck*, 1801.

Generic Character. Shell equivalve, inequilateral, irregularly and roundedly oblong or trapezoidal; valves sometimes smooth, sometimes entirely covered with radiating striæ, at others the central portion is smooth, with the lateral extremities striated; pedal region small, umbones subterminal; hinge-margin generally smooth, sometimes crenulated, edentulous; connexus bipartite; impressions of the adductors unequal; shell slightly gaping for the passage of a byssus; epidermis in the recent state often produced into long, beard-like fringes; interior of shell nacreous.

Animal with the margins of the mantle without fringe; foot cylindrical, elongated; spins generally a fine and ample byssus.

This is, as it were, an emanation from the last, with a further approach towards the true *Dimyaria*. Unlike the preceding, in which the umbo is pointed and terminal, the animals of this genus extend their shells beyond the beak on the pedal side, altering their form from the wedge-shape of *Mytilus* to the sub-rhomboidal shape of this. In *Mytilus* the oral adductor is immediately beneath the umbo, but in this genus it is beyond it, and on the inner side of the cartilaginous portion of the connexus there is generally a deeply impressed mark of the pedal muscle.

The habits of these animals in the living state are variable; many of the species spin a byssus, by which they are constantly fixed, and this byssus in some is so enlarged as to envelop the shell in a kind of nest; others bore into the test of an Ascidian; while for some cylindrically formed shells, such as *M. lithophagus*, Linn., a habitation is excavated in corals, shells, and the hardest limestone rocks; these latter, from such habits and their cylindrical form, have by some naturalists been considered as entitled to a distinct generic position (*Lithodomus*, Cuv.). These boring shells are found in the Oolites, in the thick shells of *Trichites* and *Astarte*, as well as in the rock itself, and shells resembling them have been met with in the Palæozoic formations.

Crenella is another section of this genus which has been put forward as a claimant for isolation; the principal, perhaps the only, distinction is the striation of the exterior, but this in itself is insufficient. Shells included in the above diagnosis possess every possible variation. In some the shell is quite smooth or naked, but in others it is less than half ornamented, increasing the extension in striation until many are entirely covered; while some have the centre smooth, with the extremities striated. This, again, is in one species reversed, the striæ only occupying the central portion.

Myopara is a name proposed as a genus by Lea in substitution of *Stalagmium*, Conrad, 1833 (Morton's 'Synopsis,' App., p. 8), for the reception of a small Eocene fossil of America, which is possibly an aberrant form of this genus, as suggested by Mr. Woodward, belonging to the section *Crenella*. It is of a more ovate outline than are the generality

of the species of this genus ; it resembles *Mytilus decussatus*, Montague, which Brown made the type of his genus *Crenella*. This small and apparently rare shell of Lea is the only recorded fossil of the Eocene period belonging to the Mytiloid family from the American beds that I am acquainted with. A few small species from the Paris basin have been recently figured and described by M. Deshayes under the generic name of *Crenella*. These French fossils have a more rounded form than any of our English species.

Modiola is generally a marine genus, and it is found in most parts of the world, and at various depths ; two or three species have, however, been found in estuaries and where the water is sometimes fresh. Mr. McAndrew gives the vertical range of *M. modiolus* from the shore to 100 fathoms.

1. MODIOLA DEPRESSA, *J. Sowerby*. Tab. XII, fig. 4.

MODIOLA DEPRESSA.	<i>J. Sow.</i> Min. Conch., t. 8, three upper figs., 1812.
—	— <i>Prestwich</i> . Proc. Geol. Soc., May, 1847, p. 404.
—	— <i>J. Morris</i> . Catal. Brit. Foss., p. 211, 1854.
—	— <i>Smith</i> . Strat. Syst. Org. Foss. Lond. Clay, p. 2.

Spec. Char. *M. testá tenui, elongatá, obtusè-cuneatá aut irregulariter trapeziformi, compressá, lævigatá ; umbonibus minutis, depressis, subterminalibus ; pedi-regione brevi, siphoni-regione elongatá et latiore ; margine ventrali subrectá.*

Shell thin, elongate, obtusely wedge-shaped or irregularly trapeziform, compressed, smooth ; umbones small, depressed, and nearly terminal ; pedal region short and rounded ; siphonal region long and broad ; ventral margin nearly straight.

Length, 2 inches.

Localities. Highgate (*Sowerby*), Sonning Hill (*Prestwich*).

"This shell is two and a half as broad as it is long, and thin ; the margin even and very regularly curved ; it is altogether very flat, particularly so at the anterior (?) side ; the beaks are very slightly prominent and are rounded ; lines of growth faint ; external coat shining and pellucid, internal pearly. It is difficult to preserve, that being so extremely tender, the clay shrinks in drying, the shells crack and scale off in pieces, else the appearance of an epidermis is almost to be recognised." (*J. Sowerby*.)

Specimens of a shell strongly resembling this from Harwich, as also from the Barn Rock, near Bognor, and from Hollyport, are in the Museum of the Geological Society, but they are not perfect enough for fair determination.

2. MODIOLA DESHAYESII, *J. Sowerby*. Tab. XIII, fig. 14, *a, b*.LITHODOMUS DESHAYESII. *J. Sow.* in Dixon's Geol. of Sussex, pp. 94, 171. t. 2, fig. 28.— — — *Morris.* Catal. Brit. Foss., p. 207, 1854.MODIOLA LITHOPHAGA. *Desh.* Coq. Foss. des Env. de Par., t. i. p. 267, t. 38, figs. 10—12.— — — *Pictet.* Traité de Palæont., vol. iii, p. 584, pl. 81, fig. 9.MYTILUS LITHOPHAGUS. *Desh.* Trait. Element, t. 37, figs. 5, 6.LYTHODOMUS SUBLITHOPHAGUS. *D'Orb.* Prod. Palæont., p. 391, No. 1083.— — — *Bellardi.* Catal. Ragon. dei foss. Numm. d'Egitto, p. 26, No. 62, 1854.MODIOLA DESHAYESII. *Desh.* An. sans Vert. du Bassin de Par., t. ii, p. 18, 1860.

Spec. Char. *M.* "testá elongatá cylindraccá, rectá; anticè tumidiore; extremitatibus obtusis; striis longitudinalibus posticè brevibus; striis transversis irregularibus, decussatis."

Length, 1 inch.

Localities. Bracklesham (*Dixon*).

France, Parnes, Chaumont (*Desh.*), Egypt, Sinde (*Bellardi*).

The figure above referred to is a copy of the one in Mr. Dixon's work. The specimen cannot now be found.

The Paris basin shell, when first described, was doubtfully considered to be a variety of the existing species, under which name it was then published. *M. Deshayes*, in his 'Hist. des An. sans Vert. du Bassin de Paris,' p. 18, has adopted the above specific one, which was given to it by Mr. Jas. Sowerby, who considered it sufficiently different to be entitled to a distinct position, and *M. Deshayes* is now of the same opinion. I regret not having been able to see the British fossil.

3. MODIOLA DIMIDIATA, *S. Wood*. Tab. XIII, fig. 5.

Spec. Char. *M.* testá tenui, depressá, subcylindraccá, elongatá; pedi-regione brevi, rotundatá, valdè inæquilaterali; dimidiatim radiatá, umbonibus depressis; margine ventrali rectiusculo.

Shell thin, depressed, nearly cylindrical, elongate; pedal region short, rounded; one half of the shell striated or rayed, the other smooth or naked; ventral margin nearly straight.

Length, $\frac{7}{8}$ ths of an inch.

Locality. Highcliff, Barton (*Edwards*).

I have seen only a single specimen of this elegant species, but it is well marked; it approaches the cylindrical and stone-eating shells called *Lithodomus*. The striæ cut the shell diagonally into two nearly equal parts, covering the whole of the siphonal region and extending from the umbo to the extremity of the margin, the other half of the shell is free from these markings, with the exception of the extreme margin on the pedal side, which has a few rays or ridges.

This species much resembles *M. Bernayi*, Desh. (An. sans Vert. du Bassin de Paris, t. 11, p. 13, Pl. 74, figs. 13—16), particularly in the outline, but it differs in having a smaller pedal region. Our shell is ornamented between the rays on the siphonal region with elevated ridges or regular lines of growth, decussating, as it were, the interspaces.

Fig. 15 is the cast of a shell in the late Mr. Dixon's collection of Eocene fossils in the British Museum; unfortunately it is without a locality. It resembles in outline the above species.

4. *MODIOLA DORSATA*, *Morris*. Tab. XIII, fig. 2.

MODIOLA DORSATA. *Morris*. Geol. Journ., vol. x, pt. i, p. 158, pl. 11, fig. 14, 1854.

"A rare species. The specimen is hardly sufficiently perfect for an exact determination of its characters. It differs from the preceding species (*M. Mitchellii*) in the umbo not being so terminal, and the form being less spathulate and more compressed." (*Morris*.)

Locality. Sundridge (*Prestwich*).

The only specimen that I have seen is the one figured, and I am unable to add to the description given by the proposer of the species. The prominent diagonal ridge is probably accidental, but the pedal side is considerably extended, if it be natural and not forced out by pressure.

5. *MODIOLA ELEGANS*, *J. Sowerby*. Tab. XII, fig. 5, *a—c*.

MODIOLA ELEGANS. *J. Sow.* Min. Conch., t. ix, left-hand figures.

— — *J. Morris*. Catal. Brit. Foss., p. 211, 1854.

MYTILUS ELEGANS. *D'Orbigny*. Prod. de Paléont., p. 391, 1850.

Spec. Char. *Testá tenui, ovato-elongatá vel subtrapezoidali, tumidá, subcarinatá; pedi-regione brevi, siphoni-regione rotundá; margine dorsali paulo angulato; striis utroque divaricatis, spatio mediano lævigato; margine ventrali subrecto.*

Shell thin, elongately ovate or subtrapezoidal, tumid, and obtusely keeled; pedal region short and rounded; dorsal margin obtusely angulated or curved; striæ on both sides divergent, middle plain; ventral margin slightly contracted; shell nacreous.

Length, $1\frac{1}{4}$ inch.

Localities. *a*, Highgate (*Wetherell*), Bognor, Richmond Park (*J. Sowerby*), Clewer Green? (*Prestwich*); *c*, Bracklesham, Barton (*Edwards*); *b*, Hordwell (*Edwards*).

This appears to have extended from the lowest to the uppermost of the Eocene deposits; it is not rare, and is subject to considerable variation. It is less pointed on the pedal side than *M. hastata*. Our shell is thin, and some specimens are so irregularly tumid as to form an obtuse keel or ridge from the umbo to the edge of the ventral margin of the siphonal region, but in others this is by no means prominent, as if this keel were

in some degree accidental. The striæ on the siphonal region of the shell extend over more than half the surface, and those upon the pedal region are few and faint, sometimes obsolete. Mr. Sowerby speaks of a denticulated margin and a dentated hinge (note, p. 32, Min. Conch.), and says that it is very abundant at Highgate. In the specimens from Bracklesham the ridges or rays are small, with broad interspaces; in those from Highgate the ridges are about the same breadth as the interspaces; those from Bramshaw have broad, flat ridges, with only narrow lines of separation, the Highgate specimens being intermediate. Casts of this or of some proximate species found at Harwich are in the Museum of the Geological Society.

There are three different forms which I have figured, considering them all to belong to the same species, from my inability to draw a line of distinction between them. Among the Highgate specimens elongated as well as abbreviated specimens may be seen; fig. 5 *a* looks like a distortion.

6. *MODIOLA EXIMIA*, *S. Wood*. Pl. XIII, fig. 6, *a*, *b*.

Spec. Char. *M. testá minimá, ovato-ellipticá, obliquá, valdè inæquilaterali, pedi-regione brevi, rotundatá; siphoni-regione latiore; spatio submediano parvo, lævigato; striis tenuibus, exilissimis; margine ventrali arcuato.*

Shell small, ovately elliptical, oblique, very inequilateral; pedal region small, short, and rounded; siphonal region broader; central region free from striæ, ventral margin rounded.

Length, $\frac{1}{10}$ th of an inch.

Locality. Highcliff, Barton (*Edwards*).

A specimen of each valve of this elegant little shell is in the cabinet of Mr. Edwards, and these are all that I have seen. I imagine them to be full grown, as the muscular markings are deeply seated; the anal adductor impression is large, of an ovate form, and situated a little beyond the hinge-line; the one in the pedal region is about half the size, situated near the umbo; the two are connected by a distinct mantle-mark. The striæ cover the surface of the shell, excepting a small space on the pedal side of the ventral region; this naked space occupies about one fourth of the surface, and it is less, comparatively, than upon any of our larger species covered with this kind of ornament. This character more especially, as well as a difference in outline, will, I consider, distinguish it from the fry or young of any other species with which it was associated. The inner margin of our shell is crenulated all round, excepting the small space in the ventral region; the crenulations on the pedal side are few and large. The umbo is moderately elevated, and the shell, for its size, appears to be strong.

7. MODIOLA FLABELLULA, *S. Wood*. Tab. XIII, fig. 9, *a—c*.

Spec. Char. *M. testá tenui, elongatá, irregulariter trapeziformi; pedi-regione parvâ, brevi; siphoni-regione elongatâ et latiore; radiato-costulatâ, costulis magnis, depressis, aliquando dichotomis; margine ventrali subsinuato.*

Shell thin, elongate, irregularly trapeziform; pedal region small and short; siphonal region elongate and broader; radiately rayed with broad, depressed ribs or riblets, which sometimes divide or bifurcate; ventral margin slightly curved.

Length, 1 inch.

Locality. Hempstead (*Edwards*).

Three specimens of this shell have lately come into the possession of Mr. Edwards, and I think they are entitled to be considered as belonging to a distinct species. The shell is different from *M. nodulifera* in its more elongated form and in the radiations not being noduliferous. *M. pectinata*, Lamarck, approaches it in some characters, but the outline is different, and that shell has more numerous radiations.

8. MODIOLA HASTATA, *Deshayes*. Tab. XII, fig. 6, *a, b*.

MODIOLA HASTATA. *Desh. Coq. Foss. des Env. de Par.*, t. i, p. 361, pl. 38, figs. 13, 14, 1824.

— — *Id. An. sans Vert. du Bassin de Par.*, t. ii, p. 13, 1860.

— ELEGANS. *J. Sow.*, in Dixon's *Geol. of Suss.*, p. 94, pl. 44, fig. 13, 1850.

MYTILUS HASTATUS. *Desh. Ency. Méthod. Vers.*, t. ii, p. 563, 1830.

Spec. Char. *M. testá ovato-elongatâ, subulatâ, valdè recurvâ; dorso obliquè angulatâ; striatâ; striis divaricatis, spatio mediano lævigato; pedi-regione brevi, profundè crenulatâ.*

Shell ovately elongate, tapering, greatly recurved; dorsal margin obliquely angular; striated striæ divaricating; central space smooth; pedal region short, pointed; margin deeply crenulated.

Length, $1\frac{1}{4}$ inch.

Localities. Brook (*Edwards*), Bognor.

There is a considerable curvature in the ventral margin of this species, and the shell is elevated into an obtuse keel curving from the umbo; in these characters it differs from *M. elegans*, and it appears to be identical with the Paris basin species. The whole of the siphonal region is deeply and coarsely striated; these striæ bifurcate towards the siphoni-lateral margin, and extend a little over the obtuse keel or ridge, beyond which they immediately become finer, and are soon lost in the naked ventral region. The pedal region is very small, angular, or obtusely pointed, and on the margin of this are a few coarse, radiating striæ or ridges. The ventral region is strongly marked with lines of growth.

9. MODIOLA MITCHELLI, *Morris*. Tab. XIII, fig. 10.MODIOLA MITCHELLI. *Morris*. Geol. Journ., vol. x, pt. 1, p. 158, t. 2, figs. 12, 13, 1854.— — — *Id.* Catal. Brit. Foss., p. 211, 1854.

Spec. Char. “*M. testá tenui, lævi, subtrigoná, anticè obtusá, posticè dilatátá; cardine marginali recto.*”

“A somewhat trigonal, depressed, and dilated shell, with the umbones obtuse, the dorsal line straight, the byssal margin nearly straight or but very slightly curved, the surface nearly smooth or faintly marked by lines of growth.” (*Morris*.)

Length, 1 inch.

Localities. New Cross, Deptford, Lee and Blackheath (*Morris*).

“This species is near to *Dreissena antiqua*, *Mell.*, but the dorsal margin is more produced, and the general character of the shell more spatulate.”

“Not rare in the upper part of the Woolwich series, but it is rarely found perfect.” Mr. Prestwich’s cabinet.

10. MODIOLA NODULIFERA, *S. Wood*. Tab. XIII, fig. 8, *a, b*.

Spec. Char. *M. testá tenui, irregulariter trapeziformi, valdè inæquilaterali; pedi-regione parvá, margine subrotundatá, siphoni-regione magná, dilatátá; extùs radiatim striatá, striis magnis, bifurcatis, noduliferis; margine ventrali incurvá.*

Shell thin, irregularly trapeziform, very inequilateral; the pedal region small and rounded, siphonal region expanded, covered with large, bifurcating, and nodulous radiations; ventral margin somewhat curved.

Length, $\frac{1}{2}$ an inch.

Locality. Barton (*Edwards*).

One specimen is all that I have seen, but its ornamentation is so different from that of any other species that I think it must be distinct. The striæ which cover the entire surface are peculiar in bifurcating at a very early period. Near the umbo they do not amount to more than half a dozen, while at the outer margin of the siphonal region as many as thirty-five may be counted; these striæ are rather broader than the intermediate spaces, and they are ornamented with a small knob or thickening at regular distances.

11. MODIOLA NYSTII, *Kicka*, MSS., sec. *Nyst*. Tab. XII, fig. 8, *a, b*.MYTILUS NYSTII. *Nyst*. Coq. Foss. Belg., p. 270, pl. 20, fig. 8 b.

— — — *Id.* Rech. Coq. Foss. de Hoesselt et Kl. Spau., p. 14, No. 35, pl. 3, fig. 35, fide *Nyst*.

— HASTATUS. *Goldf.* Petr. Germ., p. 179, pl. 131, fig. 13.

Spec. Char. *M. testá elongato-ovatá, obliquá, incurvá, striatá; striis numerosis, radiantibus, divaricatis, spatio mediano lævigato; pedi-regione brevī, margine rotundato, crenulato; regione dorsali subarcuato.*

Shell elongately ovate, oblique, incurved, striated; striæ numerous, radiating, and divaricating; middle portion smooth; pedal region short, with rounded and crenulated margin; hinge-line somewhat arched.

Length, 2 inches.

Localities. Brockenhurst (*Edwards*).

Belgium, Hoesselt (*Nyst*).

This does not appear to be rare in England.

I agree in opinion with M. Nyst, that this is quite distinct from *M. hastata*, Desh., but that it is the one so called by Goldfuss. Our shell agrees precisely with the Belgian fossil. This appears to be intermediate in form between *M. elegans* and *M. hastata*; it has a greater curvature in the ventral region than that of the former, but less so than in the latter, and it attains to a greater magnitude than either. The rays multiply upon the older portion of the shell, having there double the number that there are upon the younger shell. The ventral region is free from rays, and the hinge appears to possess two or three teeth. These are wholly irrespective of the denticulated margin produced by the few coarse rays which cover the pedal region.

12. MODIOLA PRESTWICHII, *Morris*. Tab. XIII, fig. 7.

MODIOLA PRESTWICHII. *Morris*. Mem. Geol. Surv., pp. 46, 147, t. 2, fig. 5, 1856.

— NYSTIANA. *Forbes*. Ut supra (name only).

— — *Morris*. Catal. Brit. Foss., p. 211, 1854.

Spec. Char. “*M. testá ovato-elongatá, angustá, subdepressá, supernè dilatatá, longitudinaliter striatá; striis numerosis obscuris, margine crenulato?*”

“An ovate, elongate shell, of somewhat spathulate form, marked with numerous radiating but rather obscure striæ.” (*Morris*.)

Length, 1 inch.

Locality. Hempstead Cliff (*Morris*).

The name of *Nystiana* was originally given to this species by the late Prof. E. Forbes, as written upon the plate above referred to. There was, however, no description appended, and the specific name having been already used in this genus, the describer considered himself justified in revoking the one first imposed, and I have for the same reason followed his example.

A mass of clay in Mr. Edwards's cabinet, with a surface an inch and a half square, has not less than twelve specimens of various sizes upon it, with the exterior upwards, and it is somewhat singular they should all lie in that position; they appear to be single valves.

With them are numerous specimens of a species of *Hydrobia*, from which I should imagine it to be an estuary species. The exterior is covered with exceedingly fine striæ, those on the siphonal region being rather larger and more distant, and the pedal side of the ventral margin is slightly contracted, giving a gentle curvature to the base. The hinge-line is straight, and extends half the length of the shell. The pedal region occupies about one fifth of the specimen.

13. MODIOLA PYGMÆA, *S. Wood*. Pl. XIII, fig. 4, *a, b*.

Spec Char. *M. testá minutá, oblongo-ellipticá, tenuissimá, tumidá, striatá, striis in medio interruptis; pedi-regione parvâ, subacutâ, angustiore; margine dorsali subangulatâ; margine ventrali subrectâ.*

Shell minute, elliptically oblong, very thin, tumid, striated, with a small, naked space in the ventral region; pedal region small, pointed; dorsal margin obtusely angulated; ventral margin nearly straight.

Length, $\frac{1}{12}$ th of an inch.

Locality. Barton (*Edwards*).

This small and elegant little shell differs from *M. eximia* in the outline, and also in the striation. The exterior is covered with striæ, except on a small space of the ventral region, which is naked. The contour of this species is less rounded than that of *eximia*, and the striæ are fewer and broader. The dorsal edge is covered with crenulations, like those on the so-called *Modiolarca*, but these are merely extensions of the prominent rays which project at the margin.

14. MODIOLA SEMI-NUDA, *Deshayes*. Tab. XIII, fig. 1, *a, b*.

MODIOLA SEMI-NUDA.	<i>Desh.</i> Coq. Foss. des Env. de Par., t. i, p. 264, pl. 39, figs. 20—22.
—	— <i>Morris.</i> Catal. Brit. Foss., p. 211, 1854.
—	— <i>Desh.</i> An. sans Vert. du Bassin de Par., t. ii, p. 12, 1860.
MYTILUS SEMI-NUDUS.	<i>Desh.</i> Ency. Méth. Vers., t. ii, p. 569, No. 36, 1850.
—	— <i>D'Orbigny.</i> Prod. de Paléont., t. ii, p. 424, No. 1634, 1850.

Spec. Char. *M. testá ovato-ellipticá, cordatá, tumidá, tenuissimá, fragili, striatá; striis exilissimis ornatá; spatio submediano lævigato; umbonibus minimis, depressis, sub-terminalibus.*

Shell ovately elliptical, heart-shaped, inflated, very thin and fragile, ornamented with very fine striæ; centre portion plain, or free from radiating ridges; umbones small, depressed, and nearly terminal.

Length, $\frac{3}{4}$ ths of an inch; *height*, $\frac{1}{2}$ an inch.

Localities. Barton (*Edwards*).

France, Senlis, Grignon (*Deshayes*).

This is an extremely delicate shell, and very rare; a few specimens, however, are quite perfect, and will bear a fair comparison. The shell to which it most nearly approaches is the common British species, *M. marmorata*, but it differs essentially in several characters; these have been pointed out by M. Deshayes, the founder of the present species. The British fossil appears to correspond with the French shell, so far as dependence can be placed upon figures and descriptions, and I have not been able to see a specimen of the latter. The striæ on the pedal region are very large or broad, becoming narrower towards the central smooth space, where they terminate with two or three very fine lines; the radiations on the siphonal region are not so broad; all the rays are flat, with narrow depressions between them. The smooth or naked central space occupies about one third of the surface of the shell, and the lines of growth are here distinctly visible, sometimes raised almost to ridges. The rays on both regions of the French shell are represented of the same size, but they are not so on ours.

One of Mr. Edwards's specimens has enclosed within its valves no less than three others, enveloping one another; one of these enveloped specimens is in a reversed position.

15. MODIOLA SIMPLEX, *J. Sowerby*. Tab. XII, fig. 7, *a*, *b*.

MODIOLA SIMPLEX. *J. Sow.*, in Dixon's Geol. of Suss., pp. 117, 225, t. 14, fig. 16, 1850.

— — *Morris*. Catal. Brit. Foss., p. 212, 1854.

Spec. Char. *M. testá tenui, elongatá, obtusè cuneatà vel subtrapeziformi, lævigatá; umbonibus minutis, depressis, subterminalibus; pedi-regione brevi, contractá; siphoni-regione latiore, compressá; margine dorsali rectá, extensá.*

Shell thin, elongated, obtusely wedge-shaped or obtusely trapeziform, smooth; beaks small, depressed, nearly terminal; pedal region very small and narrow; siphonal region broad and compressed; dorsal margin straight and extended.

Length, $1\frac{3}{4}$ inch.

Localities. Bognor and Herne Bay (*Edwards*).

Mr. Sowerby says, "It is like *M. depressa* of 'Min. Conch.,' but is more pointed."

There appears also to be a little difference in outline; the dorsal margin is less curved and more extended, and the siphonal region is rather more compressed.

16. MODIOLA SUBCARINATA, *Lamarck*. Tab. XII, fig. 9.

MODIOLA SUBCARINATA. *Lam.* Ann. du Mus., t. vi, p. 222; and t. ix, pl. 17, fig. 10 *a*, *b*.

— — *J. Sowerby*. Min. Conch., pl. 210, fig. 1, 1818.

— — *Desh.* Coq. Foss. des Env. de Par., t. i, p. 256, pl. 39, figs. 4, 5.

— — *Morris*. Catal. Brit. Foss., p. 212, 1854.

— — *Desh.* An. s. Vert. du Bassin de Par., t. ii, p. 25, 1860.

MYTILUS — *D'Archiac*. Foss. du gr. numm. dans Mém. de la Soc. Géol. de Fr., 2 sér., t. iii, pp. 433, 453, 1850.

Spec. Char. *M. testá tenui, ovato-oblongá, obliquá, gibbosá, lævigatá, subcarinatá, valdè inæquilaterali, siphoni-regione latiore; margine ventrali incurvatá, margine dorsali convexiusculá; striis accretionis notatá.*

Shell thin, ovately oblong, oblique, gibbous, smooth or with visible lines of growth, subcarinated; very inæquilateral, with siphonal region the broader; ventral and dorsal margins curved, but not parallel.

Length, 2 inches.

Localities. Highgate (*Wetherell*), Newnham? (*Prestwich*).

Mr. Sowerby, in 'Min. Conch.' above referred to, considers this as doubtfully identical with the Paris basin shell, but thinks it probable it may be the same as *M. modiolus* of Brocchi.

In the first part of 'Coq. foss. des Env. de Par., t. i, p. 256, M. Deshayes has rejected the British fossil from among his synonyms on account of its dissemblance, but he has admitted it with a mark of doubt in his second part (Descr. des An. s. Vert., t. 2, p. 25). I am unable to throw any light upon this disputed point, and have therefore left it with the name originally given by Mr. Sowerby, but I fully agree with the French author that it cannot be united to *M. modiolus*, Linn. M. Deshayes says his shell very closely resembles an oriental species which Mr. Hanley has named *Modiola Metcalfei*, except that in the recent shell the dorsal edge is more elongated; but it is not so in our fossil, which bears a very strong resemblance to the Indian shell, and I think it probable the three may be united under one name. There is in the recent British species and Crag fossil, *M. modiolus*, considerable variation, more so than is exhibited between the Eocene fossil and the Indian species.

17. MODIOLA SULCATA, *Lamarck*. Tab. XIII, fig. 11.

MODIOLA SULCATA.	<i>Lam.</i> Ann. du Mus., t. vi, p. 222; and t. ix, pl. 17, fig. 11 <i>a, b</i> .
— —	<i>Desh.</i> Coq. foss. des Env. de Par., t. i, p. 258, t. 39, figs. 9, 10.
— —	<i>Morris.</i> Catal. Brit. Foss., p. 212, 1854.
— —	<i>Desh.</i> An. sans Vert. du Bassin de Par., t. ii, p. 15, 1860.
MYTILUS SULCATUS.	<i>Desh.</i> Ency. Méth. Vers., t. iii, p. 566, No. 26, 1830.

Spec. Char. "Testá elongatá, spathulatá, obliquá, depressá, anticè posticèque longitudinaliter sulcatá, in medio lævigatá; umbonibus minimis; margine antico brevissimo, crenulato."

Shell elongate, spathulate, oblique, depressed, both sides striated or radiated; central portion smooth; umbones small; anterior margin (pedal region) very short, crenulated.

Length, $\frac{3}{4}$ ths of an inch.

Localities. Barton (*Edwards*).

France, Grignon, Parnes (*Deshayes*).

There is a single specimen only of this species in Mr. Edwards's cabinet, and this unfortunately is not in very perfect condition, but the figure is faithful, though a little improved. Our shell strongly resembles the figure and description of the French fossil above referred to, and I think it may be safely considered as belonging to that species. A recent species has this name, but it is quite distinct. M. Deshayes says the fossil is entitled to priority.

18. *MODIOLA TENUISTRIATA*, *Melleville*. Tab. XIII, fig. 3.

MODIOLA TENUISTRIATA. *Mellv.* Mém. sur les Sab. Tert. Inf. du Bass. de Par. (Ann. des Sc. Géol., 1843), p. 39, pl. 2, figs. 17—19; and pl. 3, figs. 9, 10.

Spec. Char. *M. testá ovato-ellipticá, tumidá, tenui, fragili, utroque pariter rotundatá, pedi-regione parvâ; superficie omnino striatá, striis tenuissimis, radiantibus; striis incrementi elevatis, decussatis.*

Shell ovately elliptical, tumid or deep, thin, and fragile, equally rounded at both extremities; exterior wholly covered with striæ; radiating lines fine and thin, decussated by elevated lines of growth.

Length, $\frac{7}{8}$ ths of an inch.

Locality. Barton (*Edwards*).

This elegant shell is very rare as a British fossil, and of extreme tenuity. M. Melleville gives two figures of his species, presenting considerable diversity of character. The British fossil corresponds more closely with his figures 9 and 10, pl. iii, both in the outline and ornament. Our shell has the umbo almost at the extremity, and very slightly projecting. The fine, radiating striæ are regularly cut by lines of growth, making the shell appear as if punctured or cancellated.

19. *MODIOLA*? *TUBICOLA*, *S. Wood*. Tab. XIII, fig. 12, *a, b*.

Spec. Char. *M. testá subcylindraccá, lævigatá, tenui, valdè inæquilaterali; marginibus dorsali et ventrali subparallelis; pedi-regione parvâ, rotundatá; siphoni-regione compressâ.*

Shell subcylindrical, smooth and thin; dorsal and ventral margin nearly parallel; very inequilateral; pedal region small and rounded; siphonal region compressed.

Length, $\frac{5}{8}$ ths of an inch; *height*, $\frac{1}{8}$ th.

Locality. Whetstone?

In the museum in Jermyn Street is a specimen of the matrix of London Clay with several tubes of the *Teredo*, and located with them are two or three individuals of a *Modiola*?; these latter have apparently taken their abode in the hollow of the tubes. The

specimens are unfortunately not very perfect, but a portion of the shell is visible on one of them; this appears to have been quite smooth and free from striæ of any kind. Assuming this cylindrical state to be the true character of the shell, it resembles that section of the genus called *Lithodomus*, but whether this form be produced from a confined position it is difficult to say. Unlike the generality of the cylindrical species, the siphonal region of our shell, if not distorted, is much compressed, and the margins are quite closed.

This species somewhat resembles *M. angusta*, Desh. (Coq. foss. des Env. de Par., t. 1, p. 266, pl. 41, figs. 6—8), but it differs in having the umbo terminal, and our shell is much more unequally tumid. The locality is unfortunately not known.

20. *MODIOLA UNDULATA*, *S. Wood*. Tab. XIII, fig. 13, *a, b*.

Spec. Char. *M. testâ tenui, depressâ, elongato-cuneatâ; siphoni-regione latiore, depressâ; extûs lævigatâ, undulatâ.*

Shell thin, depressed, elongately wedge-shaped; siphonal region broad, depressed; externally smooth, and undulating.

Length, 2 inches.

Localities. Harwich and Bawdsey.

There are two specimens of *Septaria* in the Museum of the Geological Society, marked respectively Nos. 8290 and 15314, presented by the Rev. J. Holmes, to which are attached the above localities; they bear the impressions and the greater part of the shell of a few specimens of a species of *Modiola*, but in a compressed and mutilated condition; they are, however, sufficiently perfect to show, by their lines of growth, that they most probably belonged to a species quite distinct from any other Eocene form, or at least from any that I am acquainted with. The undulations of the exterior do not look as if they could have been produced by compression or accident.

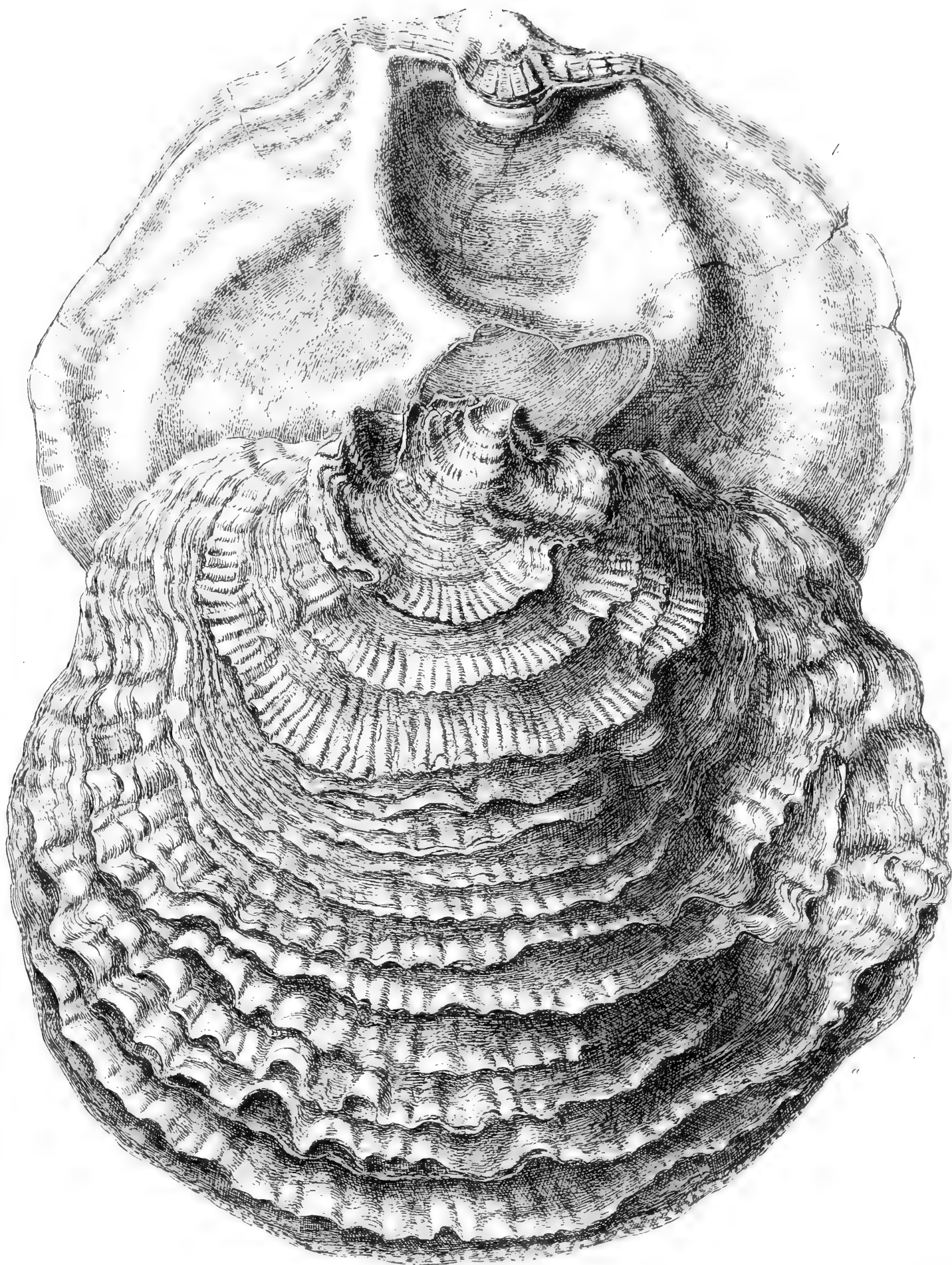
The entire figure (*b*) is a restoration.

Tab. X, fig. 5, represents the fragment of a shell which appears to belong to this genus, and the ornamentation is so peculiar that I think it deserves to be represented in order to call attention to its existence. It is from Highcliff, Barton, and is in Mr. Edwards's cabinet. The striæ, or rather costæ, which cover the dorsal portion of the siphonal region, are few and very large, differing from those upon the other part of the shell, from which character it might be called *diversa*. Some species have the striæ of the same magnitude all over the surface, in others the striæ are smaller or narrower on the dorsal portion of the siphonal region, and this diversity is, I think, a good mark of distinction.

TAB. I.

Ostrea pulchra, *page* 30.

Specimen from near Reading, with connexus preserved. Mus. Edwards.



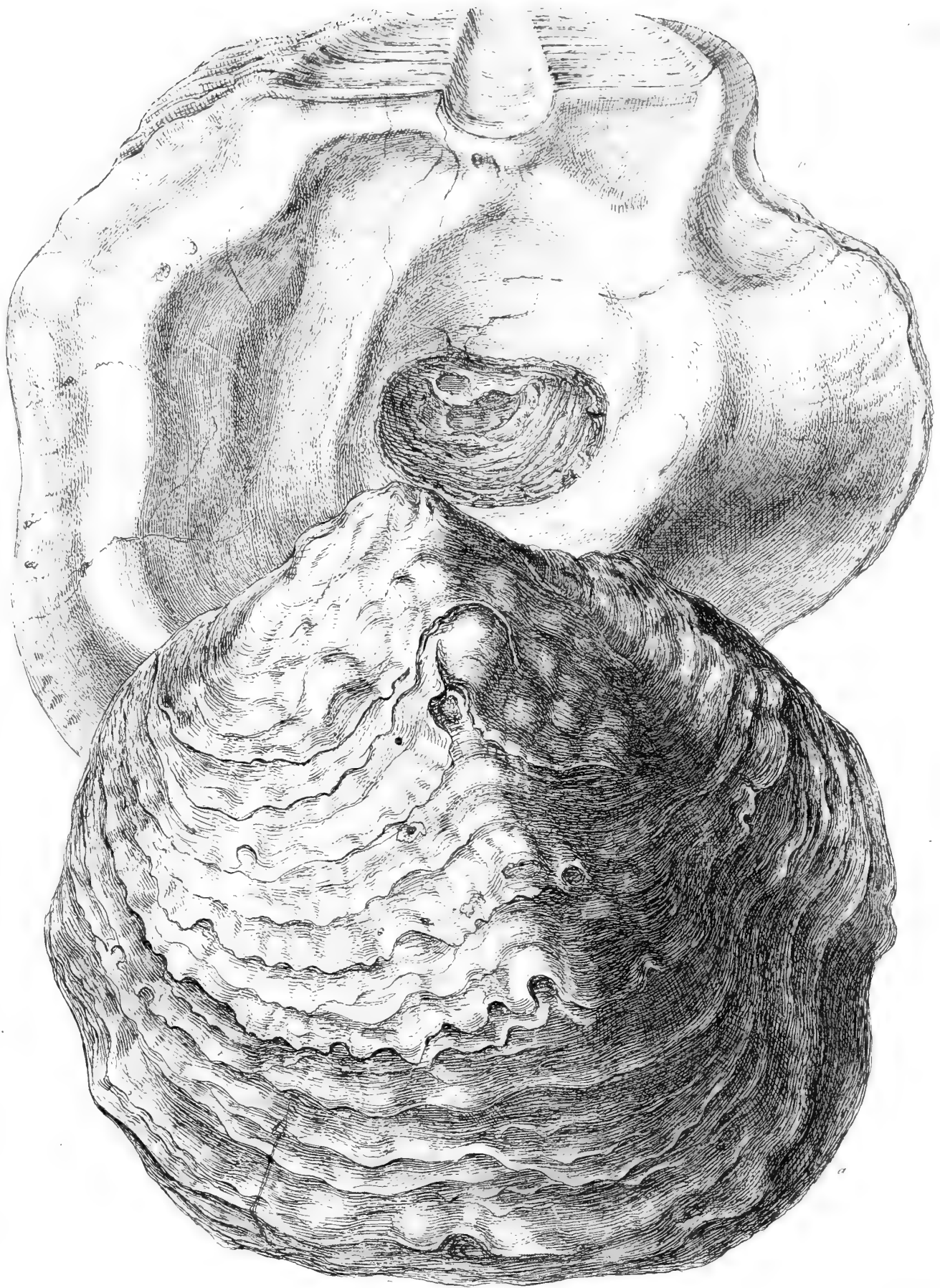
TAB. II.

Ostrea gigantea, *page* 23.

a. outside view of lower valve, showing a very small mark of attachment.

Mus. Bowerbank.

b. inside view of upper or right valve. Mus. Edwards (? elephantopus).



TAB. III.

FIG.

1. *Ostrea Bellovacina*, *page* 17.

a. outside view of upper valve from Charlton. Mus. Edwards.

b. outside view of lower valve „ „

2. *Ostrea cymbuloides*, *p.* 20.

From Herne Bay. Mus. Bowerbank.

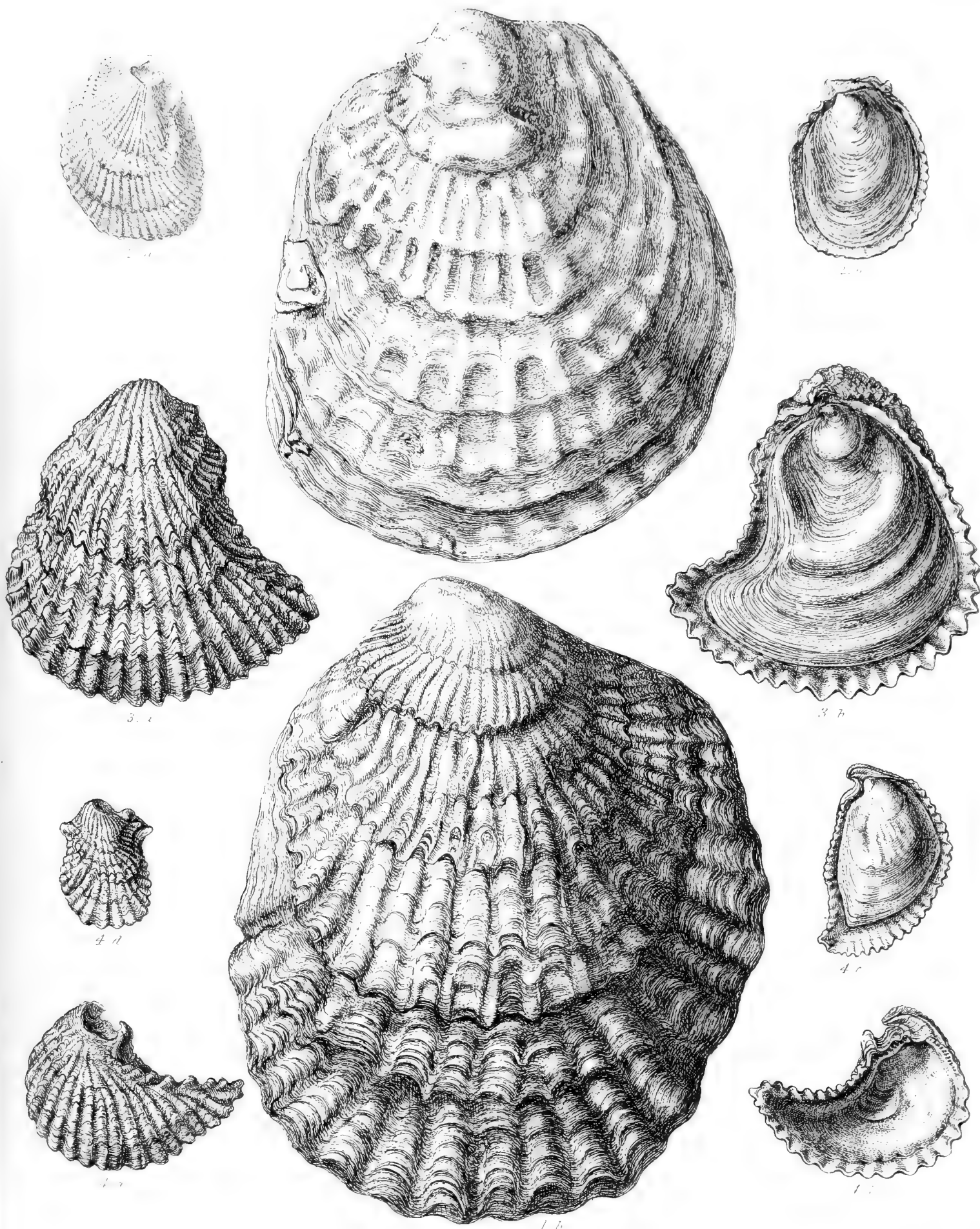
3. *Ostrea prona*, *p.* 29.

From Brockenhurst. Mus. Edwards.

4. *Ostrea flabellula*, *p.* 21.

a. outside, normal form, from Bramshaw. Mus. Edwards.

d. outside, abnormal form, from Barton. „



TAB. IV.

FIG.

1. *Ostrea tabulata*, *page* 31.

a. outside view, upper valve, from Bognor. Mus. Edwards.

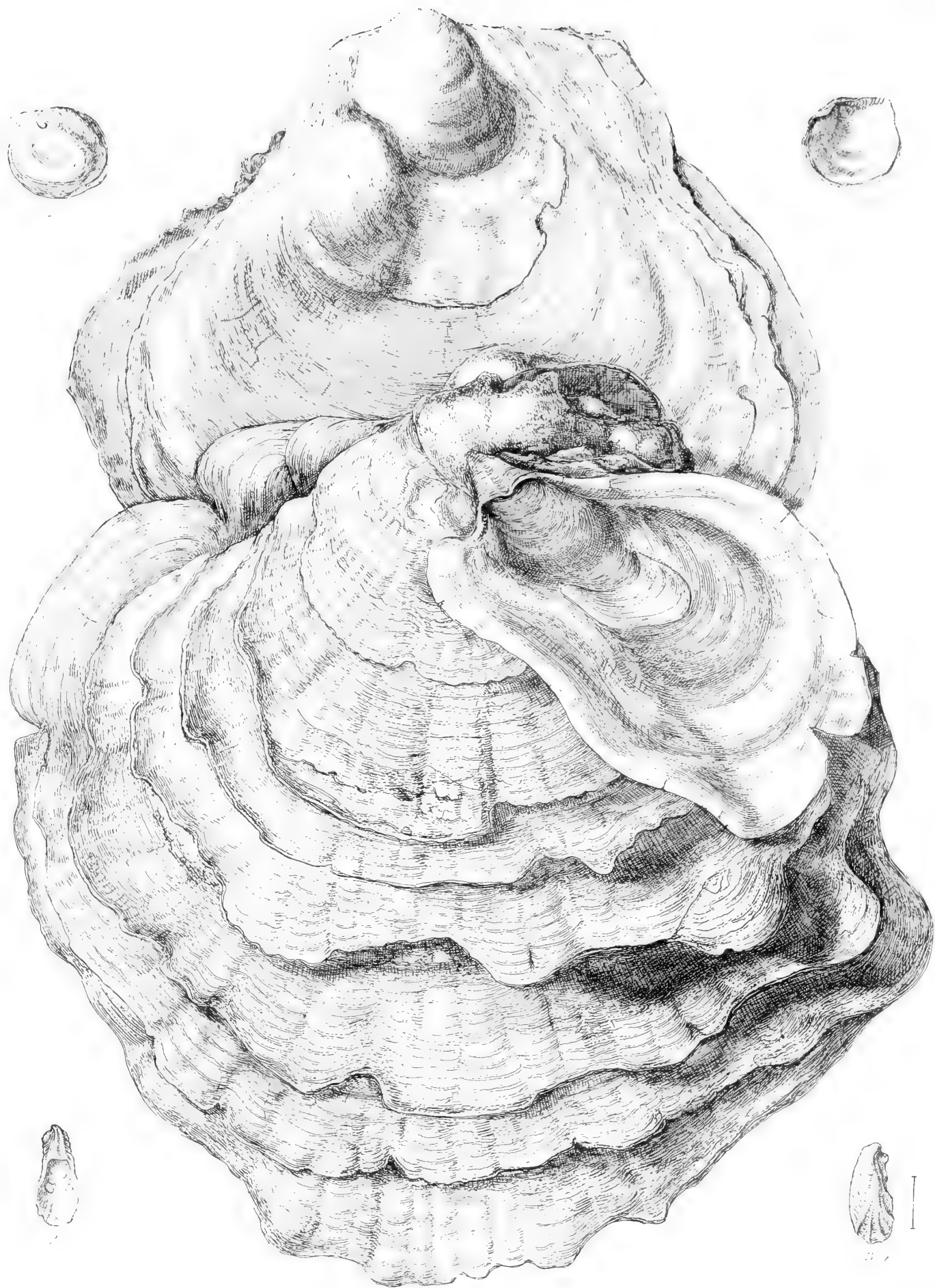
b. outside view, lower valve, „ Mus. Jermyn Street.

2 *a.* outside view of the upper valve of an oyster from Clarendon, with greatly incurved umbo like *Exogyra*; supposed to be the young state of *O. pulchra*. Mus. Edwards.

2 *b.* inside of another specimen, with margin denticulated near the hinge, same locality, supposed also to be the young state of *O. pulchra*. Mus. Edwards.

3. *Ostrea flabellula* juv.? *page* 21.

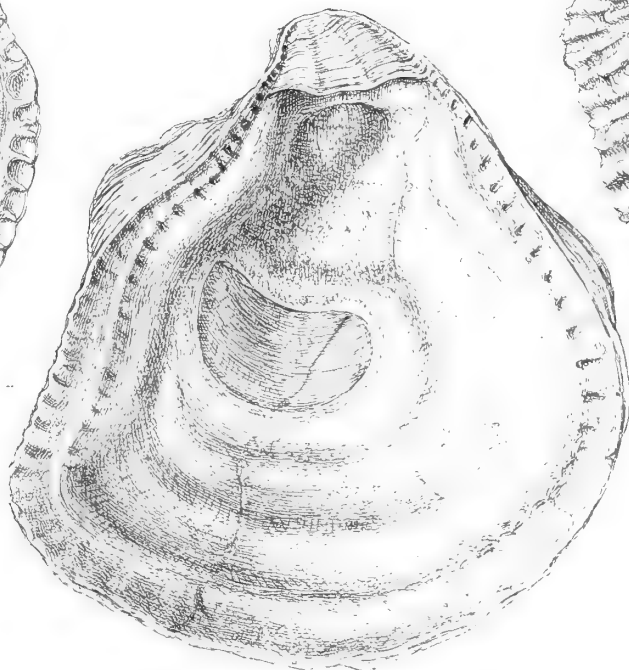
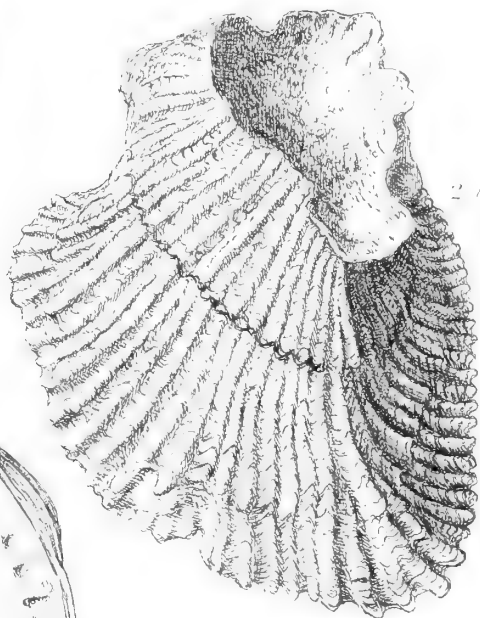
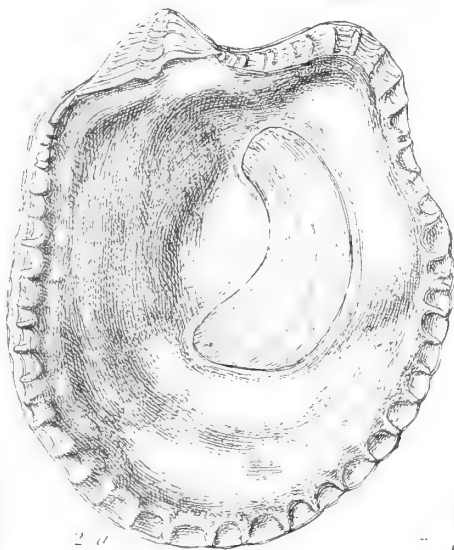
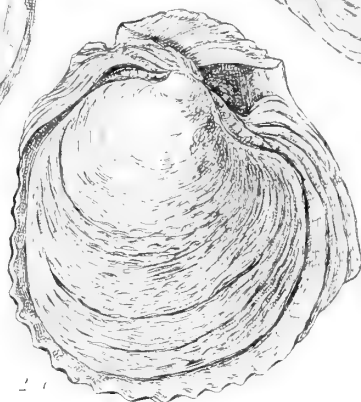
From Barton. Mus. Edwards.



TAB. V.

FIG.

1. *Ostrea callifera*, *page* 18.
 - a.* inside view of lower valve. Mus. Jermyn Street.
 - b.* united valves, umbo inflected in a contrary direction. Mus. Edwards.
2. *Ostrea adlata*, *p.* 16.
 - a, b.* out and inside views of lower valve. Mus. Edwards.
 - c.* inside view of upper valve. Mus. Edwards.
 - d.* inside view of lower valve, abnormal state. Mus. Edwards.
3. *Ostrea marginidentata*, *p.* 27.
 - a.* inside view of upper valve, showing the altered form of muscle-mark. Mus. Edwards.
 - d.* inside view of lower valve, with normal form of muscle-mark. This specimen had been attached by the entire outer surface. Mus. Edwards.



TAB. VI.

FIG.

1. *Ostrea tenera*, *page* 31.

Specimen from Bracklesham. Mus. Edwards.

2. *Ostrea dorsata*, *p.* 20.

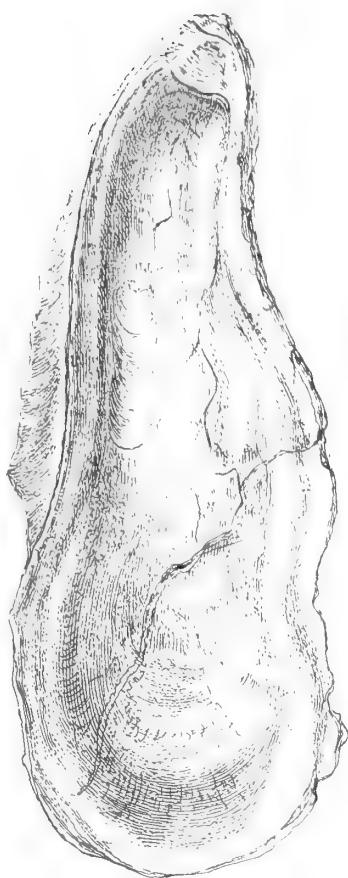
Specimen with united valves, showing it to have been attached to some cylindrical body, which circumstance had communicated a semi-cylindrical elevation to the centre of both valves. Mus. Edwards.

3. *Ostrea multicostata*? *p.* 28.

From Bracklesham. Mus. Edwards.

4. *Ostrea longirostris*, *p.* 26.

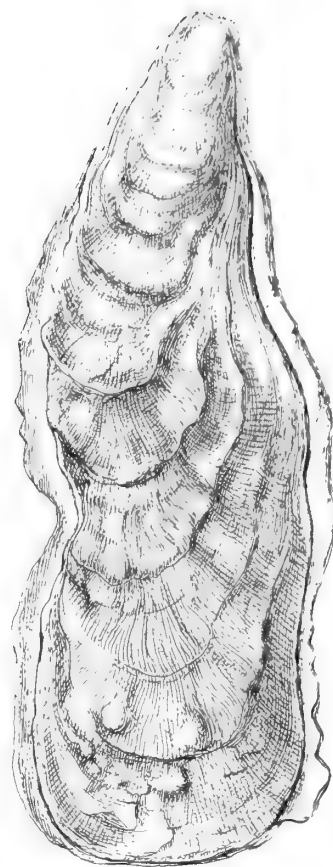
Specimen of lower valve, with a broad mark of adherence. This specimen has been perforated by several stone-eating bivalves. Mus. Edwards.



1. 11



2. 11



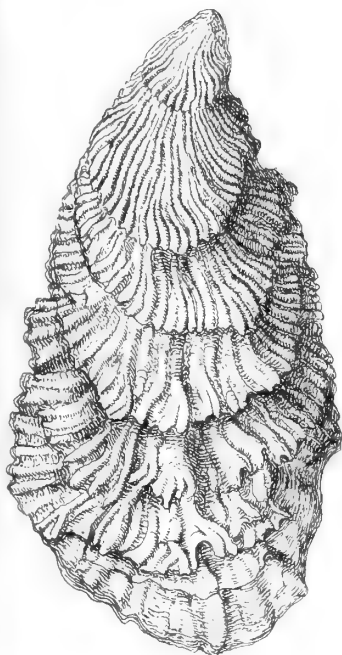
1. 12



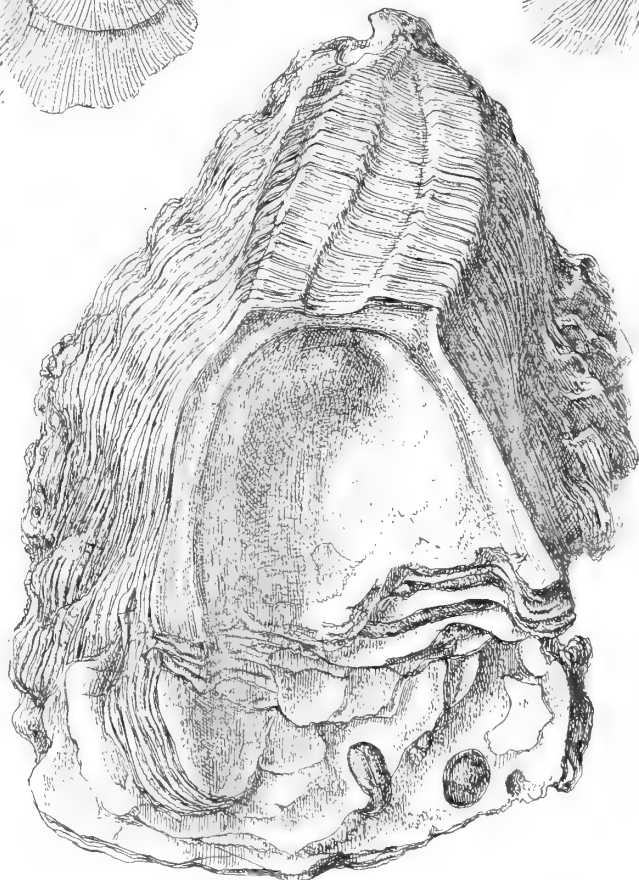
2. 12



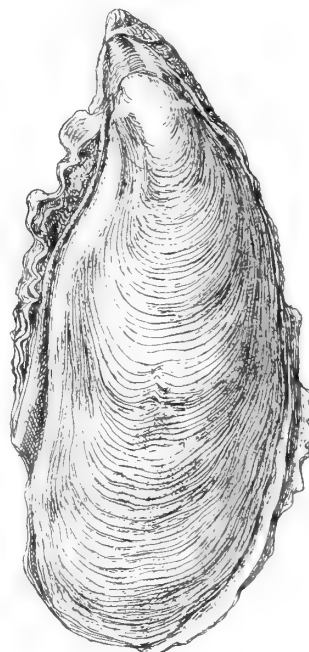
1. 13



1. 14



1. 15



3. 16

TAB. VII.

FIG.

1. *Ostrea velata*, *page* 33.

b. outside view of upper valve, showing the broad striæ. Mus. Edwards.

2. *Ostrea picta*, *p.* 28.

Mus. Brit.

3. *Ostrea Bellovacina*, *p.* 17.

a. outside view of lower valve, from Peckham. Mus. Edwards.

b. inside of upper valve, from Peckham. The exterior of this specimen is free from radiating costæ. Mus. Edwards.

c. portion of the outside of upper valve of another specimen from Peckham. Mus. Edwards.

4. *Ostrea inflata*? *p.* 26.

Mus. Edwards.

5. *Ostrea Vectiensis*, *p.* 32.

a. inside view of right valve. Mus. Jermyn Street.

b. „ left valve. „

(? *Ostrea gryphina*. Forbes.)

c. inside of upper valve of a very thick (old?) specimen, much elevated. Mus. Jermyn Street.

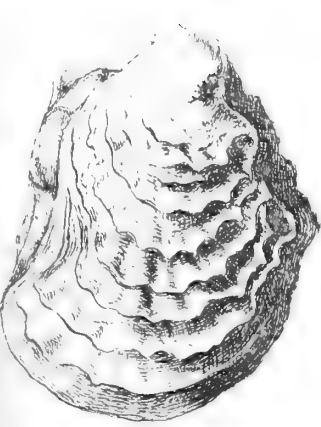
(? *Ostrea Sparnacensis*.)

6. *Ostrea gryphovicina*, *p.* 25.

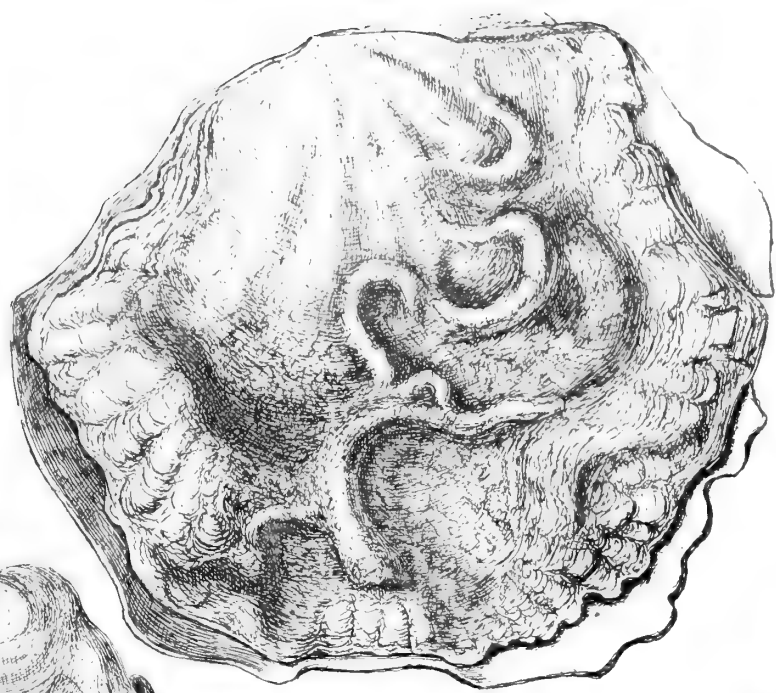
a. outside view of lower valve. Mus. Wetherell.

b. inside of the lower or left valve, showing the linear hinge-area. Mus. Bowerbank.

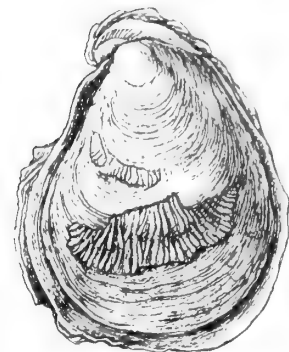
7. *Ostrea cyathula*? *p.* 19.



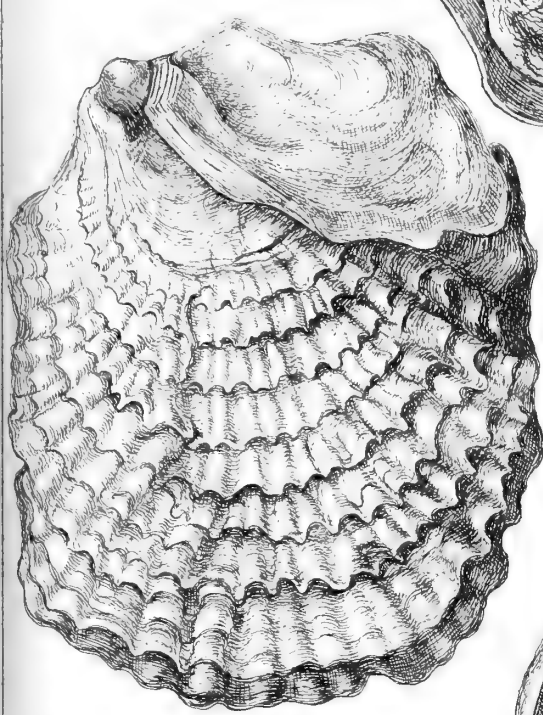
1. a



2



1. b



3. a



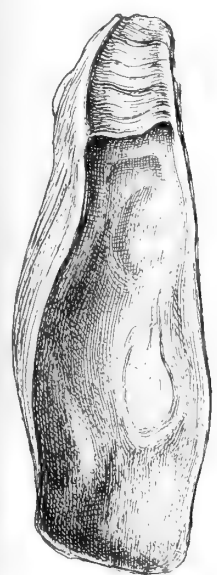
4



3. b

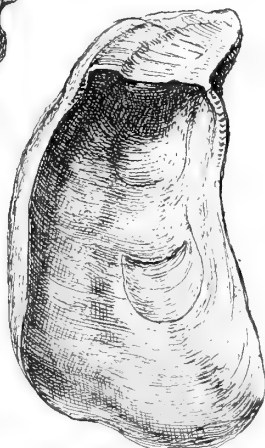


3. c

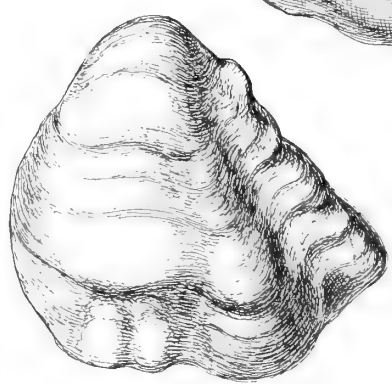
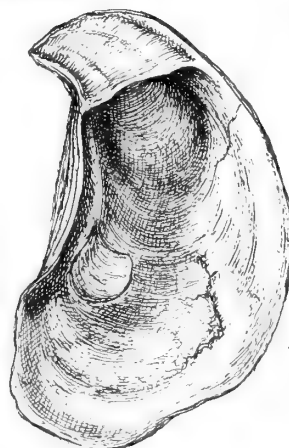


5. c

5. a



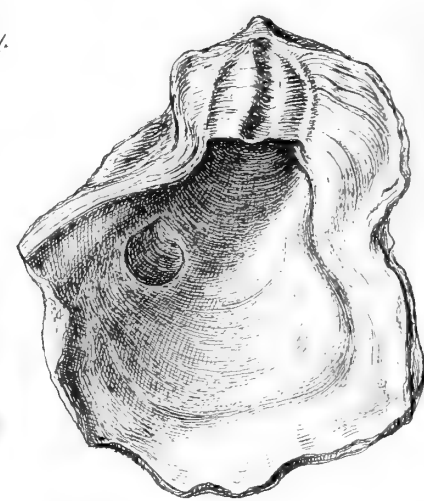
5. b



6. a



7



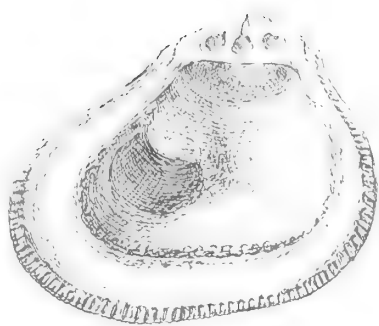
6. b

TAB. VIII.

FIG.

1. *Spondylus rarispina*, *page* 51.
 - a.* view of the inside of the left or free valve.
 - b.* „ „ outside of the same. Mus. Edwards.
2. *Ostrea aliena*, *p.* 16. Mus. Edwards.
3. „ *cyathula*, *p.* 19. „
4. „ *zonulata*? *p.* 34. „
5. „ *flabellula* (*var. modicella*), *p.* 21. Mus. Edwards.
6. „ *gigantea*, *p.* 23. Mus. Edwards.
7. *Pecten Prestwichii*, *p.* 42.
 - a.* left valve. Mus. Bowerbank.
 - b.* right valve. Mus. Prestwich.

The portion beyond the fracture in the right valve is made up.
8. *Pecten 30-radiatus*? *var. 40-radiatus*, *p.* 45. Mus. Brit.
9. *Pecten idoneus*, *p.* 41. Mus. Edwards.
10. *Pecten duplicatus*, *p.* 41.
 - a.* view of the outside of the right valve. Mus. Edwards.
 - b.* „ „ „ left valve, with imperfect? auricles. Mus. Edwards.
 - c.* view of the inside of the left valve of a more elevated specimen. Mus. Wetherell.
11. *Pecten bellicostatus*, *p.* 38. Mus. Edwards.



1. b



3



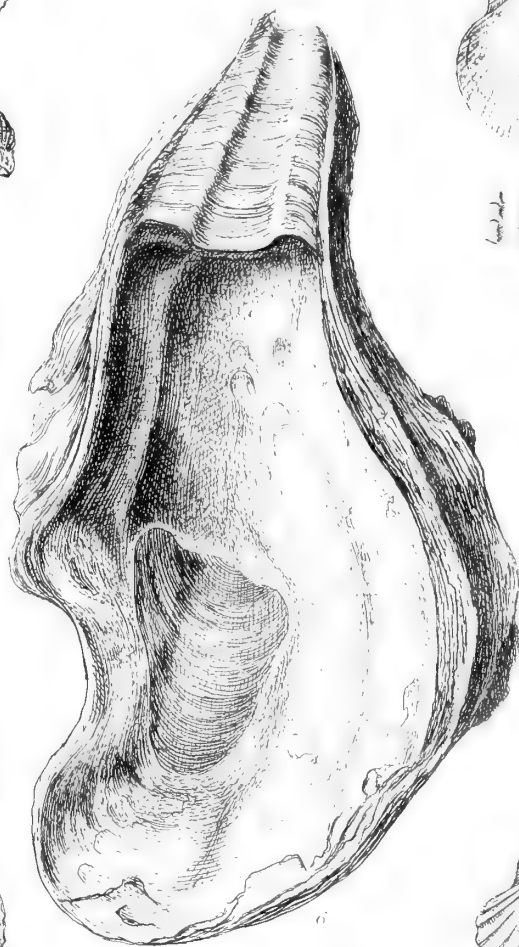
5. a



5. b



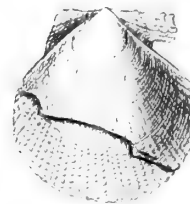
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6

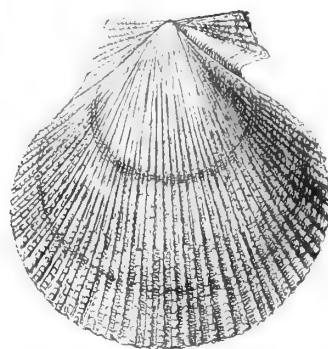


7. a



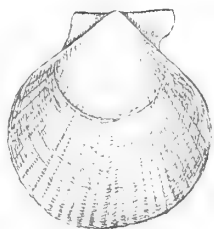
7. b

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Scapharca
Scapharca



8

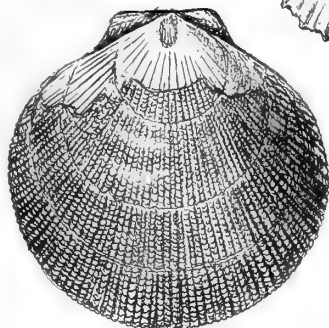
Small text: *Scapharca*
Scapharca
Scapharca



10. a

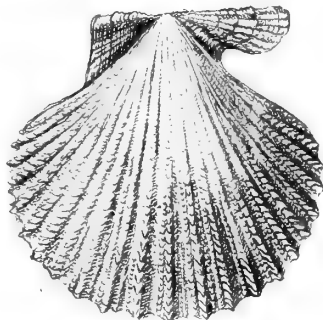


10. c

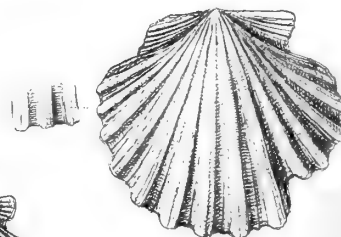


10. b

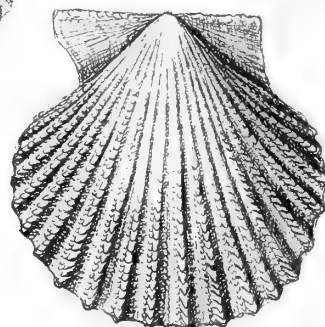
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Scapharca
Scapharca



9. b



9. a



9. b

Small text: *Scapharca*
Scapharca
Scapharca

TAB. IX.

FIG.

1. *Anomia tenuistriata*, *page* 13.

- a.* view of outside of the upper valve, normal form. Mus. Edwards.
- b.* „ inside of the lower valve. Mus. Edwards.
- c.* „ outside of the upper valve, with radiations. Mus. Edwards.
- d.* „ inside of the upper valve, showing muscular impressions. Mus. Edwards.
- e.* specimen showing the disproportion of united valves. Mus. Edwards.

2. *Vulsella deperdita*, *p.* 35.

- a.* view of a united pair of valves of medium form. Mus. Edwards.
- b.* right valve of a depressed specimen. Mus. Edwards.
- c.* view of outside of the left valve of an elevated specimen. Mus. Jermyn Street.

3. *Pecten reconditus*, *p.* 42.

- ? *a.* orbicular specimen from Barton, with thirty rays.
- b.* left valve of an elevated specimen, with eighteen rays.
- c.* right valve of an elevated specimen, with twenty rays.

4. *Pecten 30-radiatus*, *p.* 45.

Right and left valves, with sections of varieties.

5. *Pecten carinatus*, *p.* 38. Mus. Edwards.

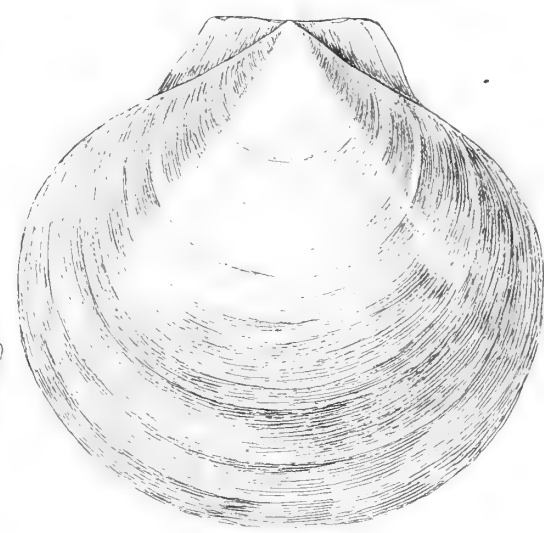
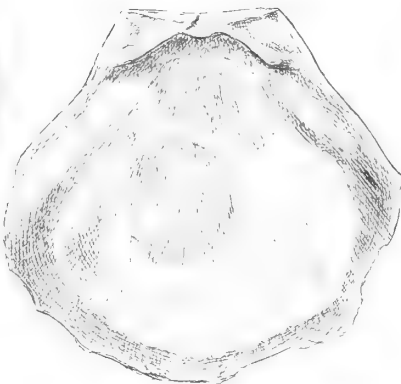
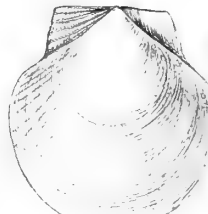
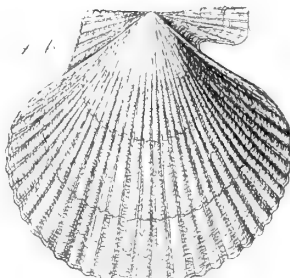
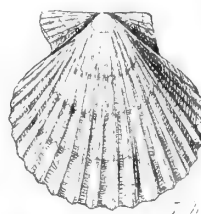
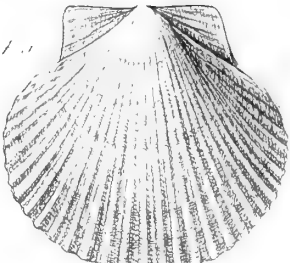
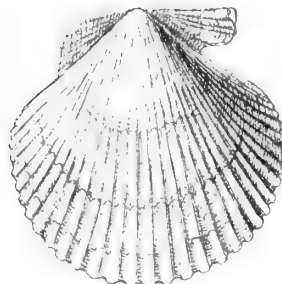
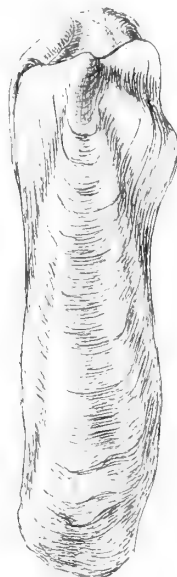
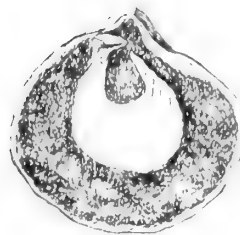
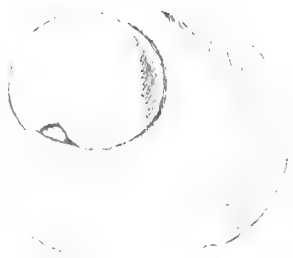
6. „ *squamula*, *p.* 44. „

The two larger figures are magnified representations.

7. *Pecten corneus*, *p.* 39. Mus. Edwards.

- a, c.* views of the outsides of the right and left valves.
- b.* view of the inside of the left valve.
- d.* „ „ of specimen from Highgate (var. *corneolus*). Mus. Edwards.

8. *Pecten contubernalis*, *p.* 40. Mus. Edwards.



TAB. X.

FIG.

1. *Pinna affinis*, *page* 55.

a. view of the left valve. Specimen from Bognor. Mus. Edwards.
c. var. *intermedia*. Mus. Prestwich.

2. *Pinna pyriformis*, *p.* 57. Mus. Prestwich.

3. *Pecten duplicatus*, *p.* 41.

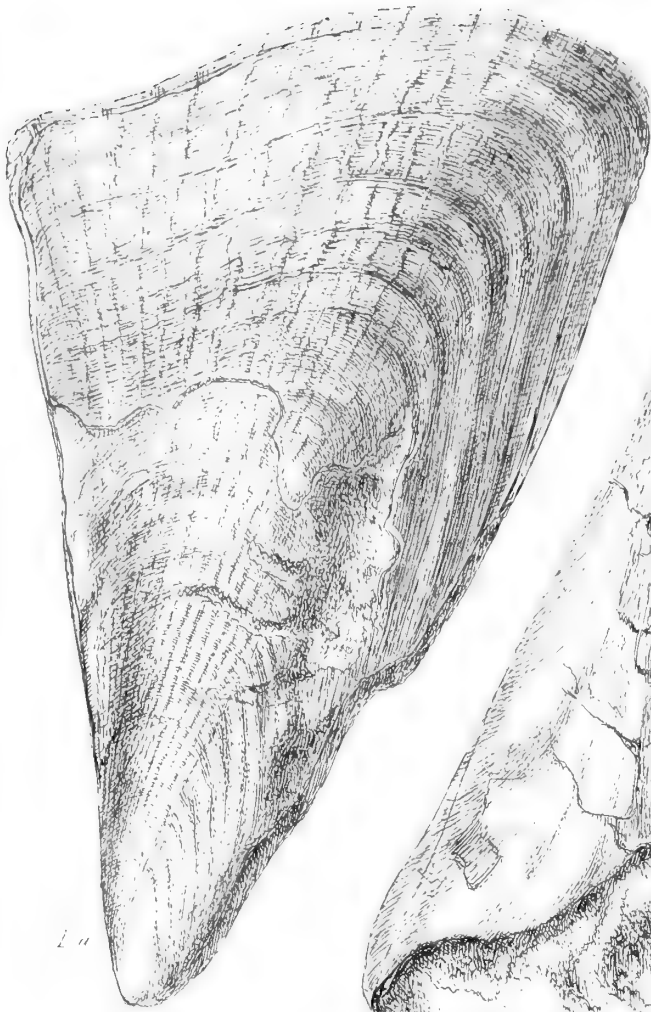
A strongly imbricated specimen of the left valve, with perfect auricles, from
Highgate. Mus. Wetherell.

4. *Ostrea zonulata*, *p.* 34. Mus. Fisher.

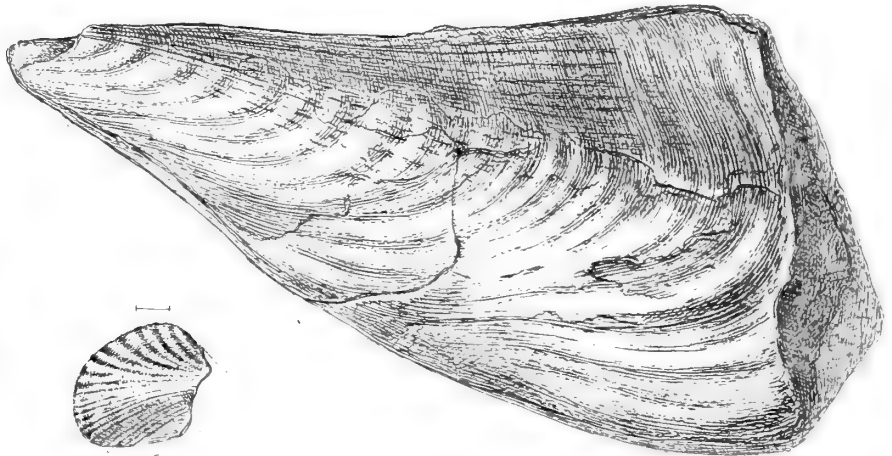
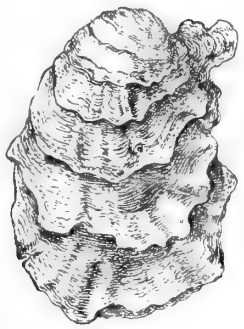
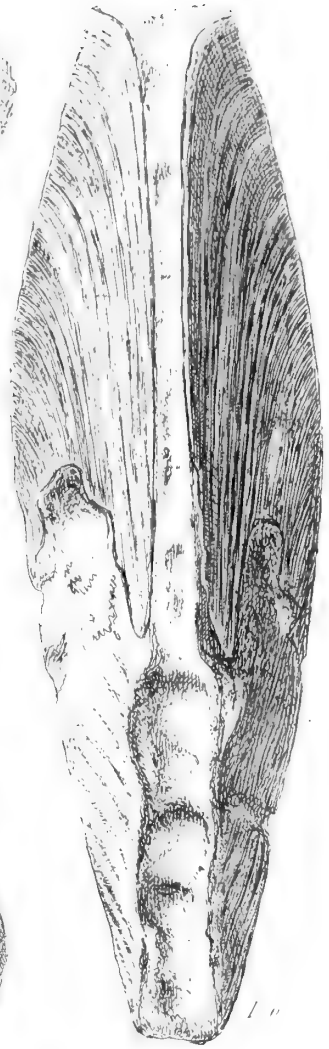
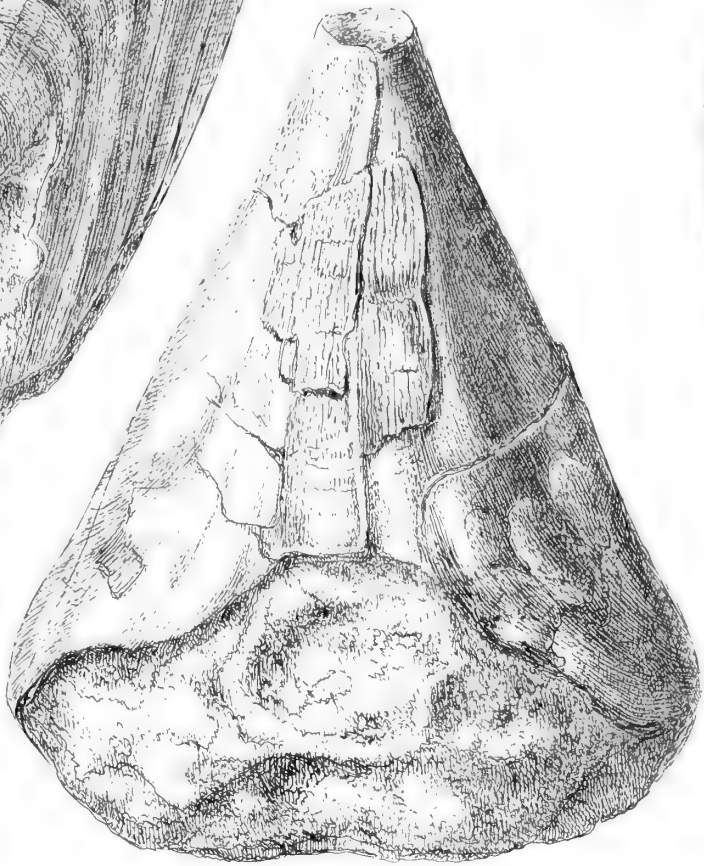
5. *Modiola diversa*, *p.* 74.

Fragment of a specimen, enlarged. Mus. Edwards.

The line denotes the size of the specimen.



1842
1843
1844

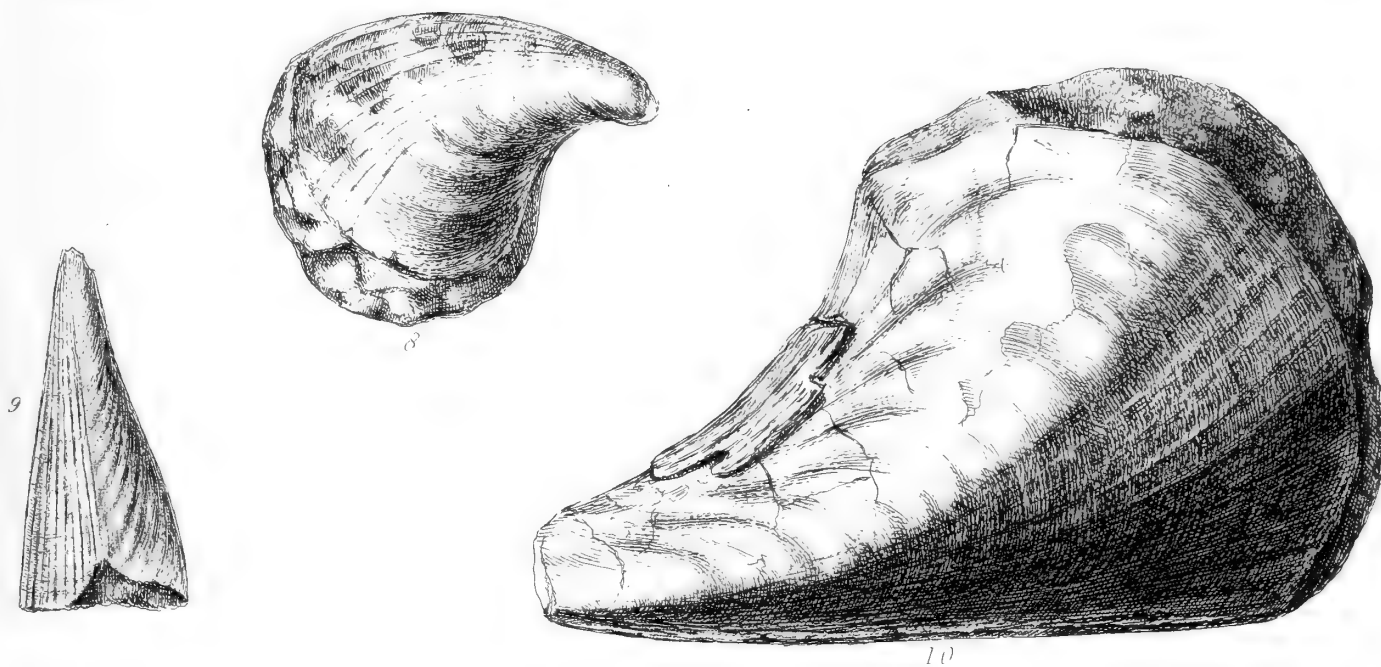
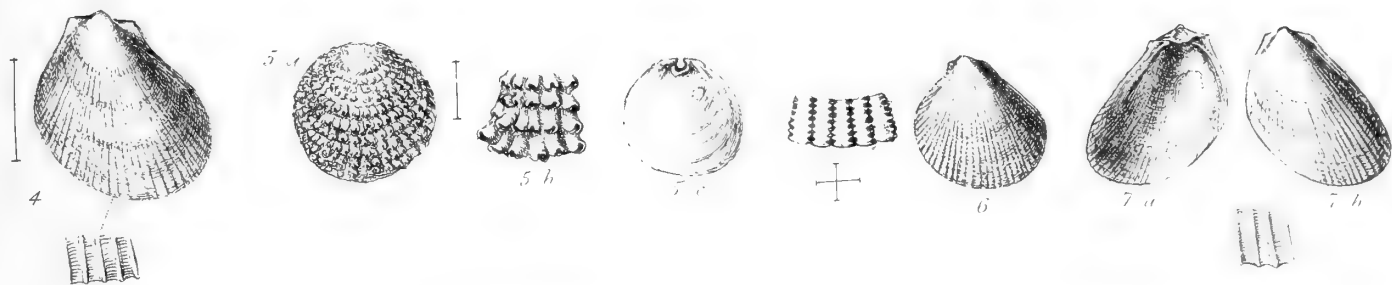
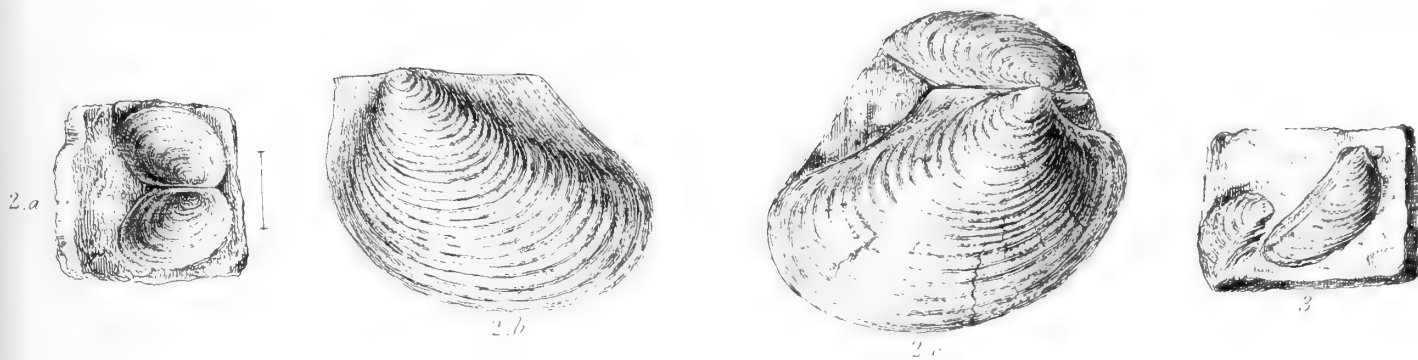
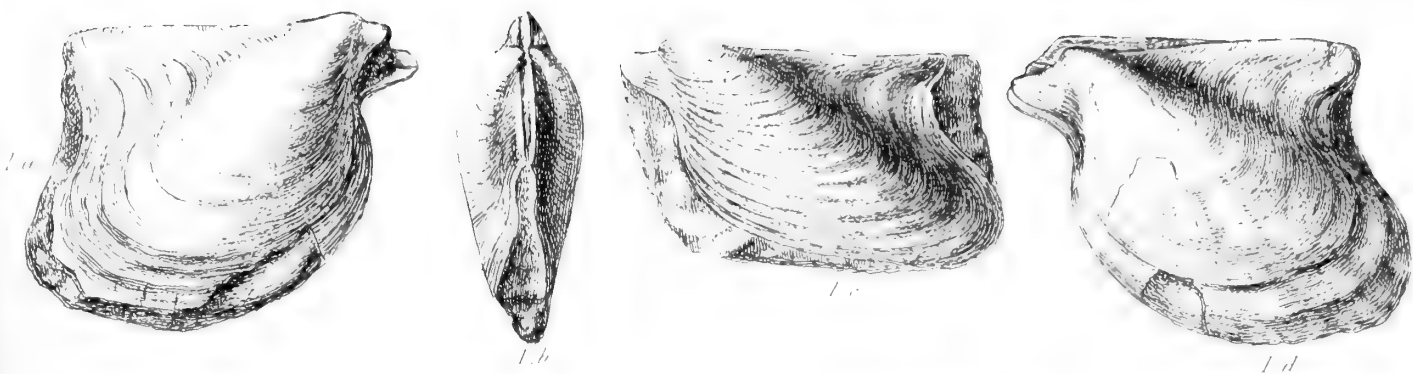


TAB. XI.

FIG.

1. *Avicula media*, *page* 53.
 - a, d.* right and left valves of an elevated specimen from Brockenhurst. Mus. Edwards.
 - b, c.* specimen from Barton. Mus. Edwards.
2. *Avicula papyracea*, *p.* 54.
 - a.* view of the interior of a young? specimen from Haverstock Hill. Mus. Edwards.
 - b, c.* adult specimens from Highgate. Mus. Edwards.
3. *Avicula arcuata*, *p.* 53. Mus. Wetherell.
4. *Lima compta*, *p.* 48. Mus. Edwards.
5. *Anomia scabrosa*, *p.* 14. „
6. *Lima expansa*, *p.* 49. „
7. „ *soror*, *p.* 49. „
8. *Pinna arcuata*, *p.* 56. Mus. J. Sowerby.
9. „ *margaritacea*, *p.* 56. Mus. Brit.
10. „ *pyriformis*, *p.* 57. Mus. Prestwich.

The lines denote the size of the specimens.



TAB. XII.

FIG.

1. *Mytilus affinis*, *page* 61.

a, c, d. specimens from Colwell Bay. Mus. Edwards. .

b. specimen from Barton. Mus. Edwards.

2. *Mytilus strigillatus*, *p.* 61. „

3. *Dreissena Brardii*, *p.* 59.

a. view of the interior of the left valve, in which is a specimen of the arenaceous case of a *SABELLA*?

4. *Modiola depressa*, *p.* 63. Specimen from Highgate. Mus. Wetherell.

5. *Modiola elegans*, *p.* 65.

a. var. *inelegans*, from Highgate. Mus. Wetherell.

b. *elegans*, from Highgate. Mus. Wetherell.

c. var. *elegantior*, from Hordwell. Mus. Edwards.

6. *Modiola hastata*, *p.* 67.

Specimens from Brook. Mus. Edwards.

7. *Modiola simplex*, *p.* 71.

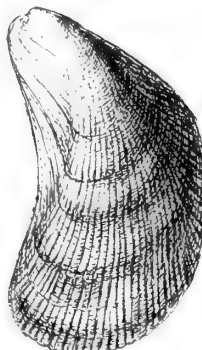
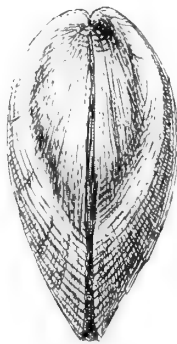
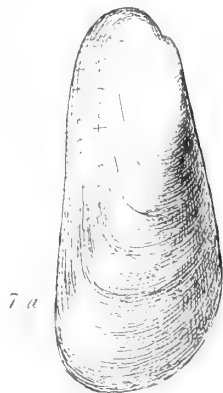
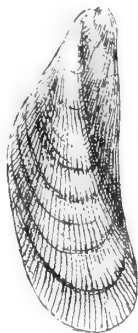
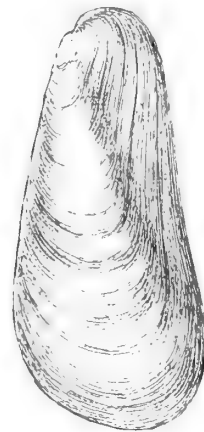
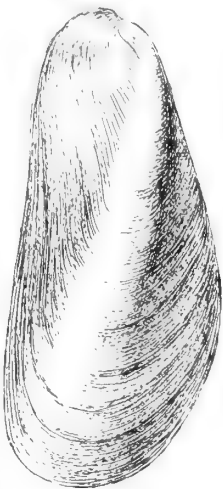
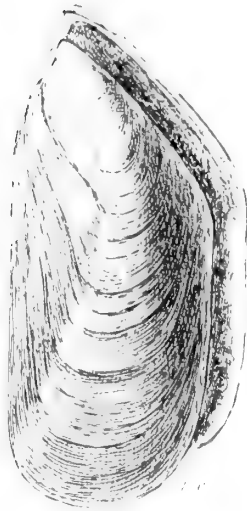
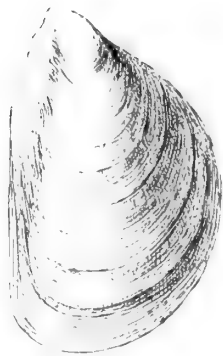
a. specimen from Herne Bay. Mus. Edwards.

b. „ Bognor. „

8. *Modiola Nystii*, *p.* 68. Mus. Edwards.

9. *Modiola subcarinata*, *p.* 71.

Specimen from Highgate. Mus. Wetherell.

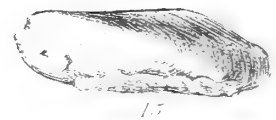
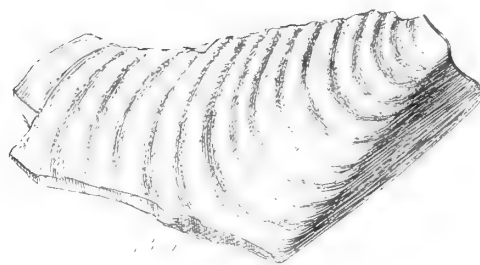
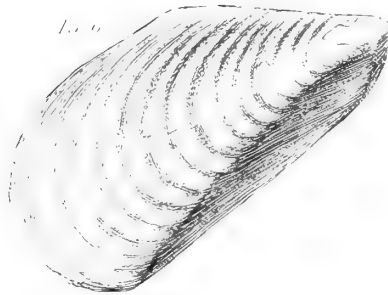
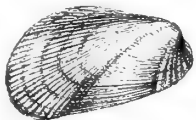
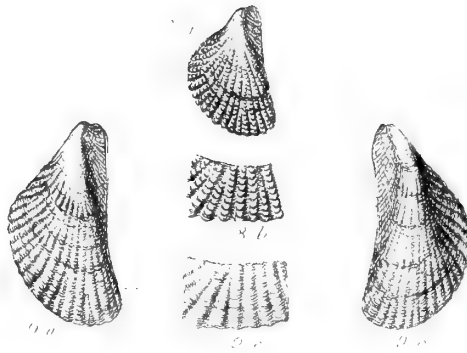
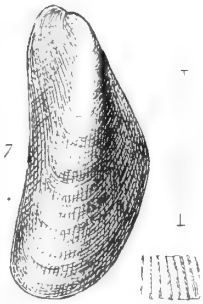
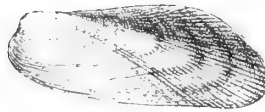
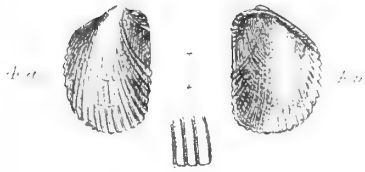
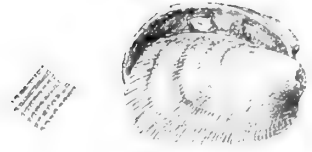
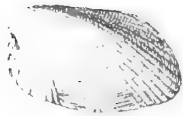


TAB. XIII.

FIG.

1. *Modiola semi-nuda*, *page* 70. Mus. Edwards.
2. „ *dorsata*, *p.* 65. Mus. Prestwich.
3. „ *tenuistriata*, *p.* 73. Mus. Edwards.
4. „ *pygmæa*, *p.* 70. „
5. „ *dimidiata*, *p.* 64. „
6. „ *eximia*, *p.* 66. „
7. „ *Prestwichii*, *p.* 69. „
8. „ *nodulifera*, *p.* 68. „
9. „ *flabellula*, *p.* 67. „
10. „ *Mitchelli*, *p.* 68. Mus. Morris.
11. „ *sulcata*, *p.* 72. Mus. Edwards.
12. „ ? *tubicola*, *p.* 73. Mus. Jermyn Street.
13. „ *undulata*, *p.* 74. Mus. Geol. Soc.
b. an imaginary specimen.
14. „ *Deshayesii*, *p.* 64.
15. „ *dimidiata*? (cast of), *p.* 64. Mus. Brit.

The lines denote the size of the specimens.



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